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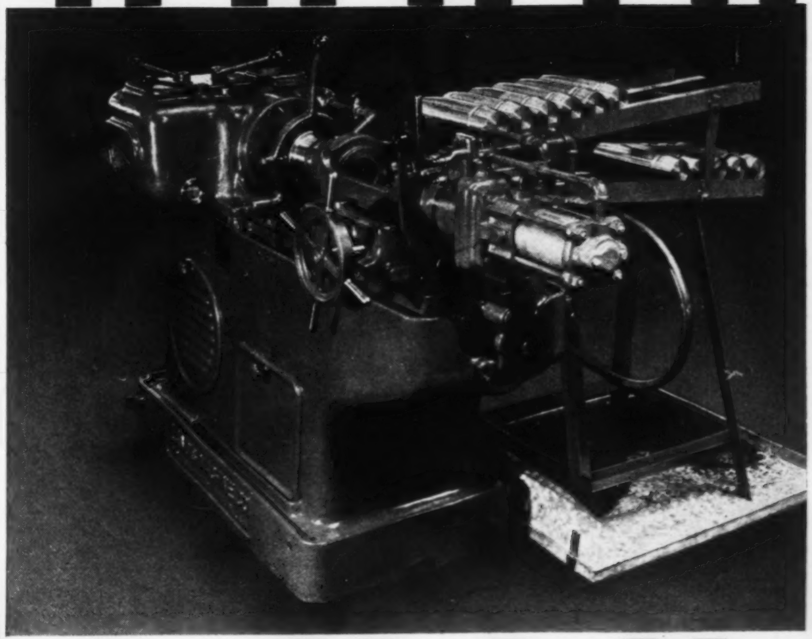

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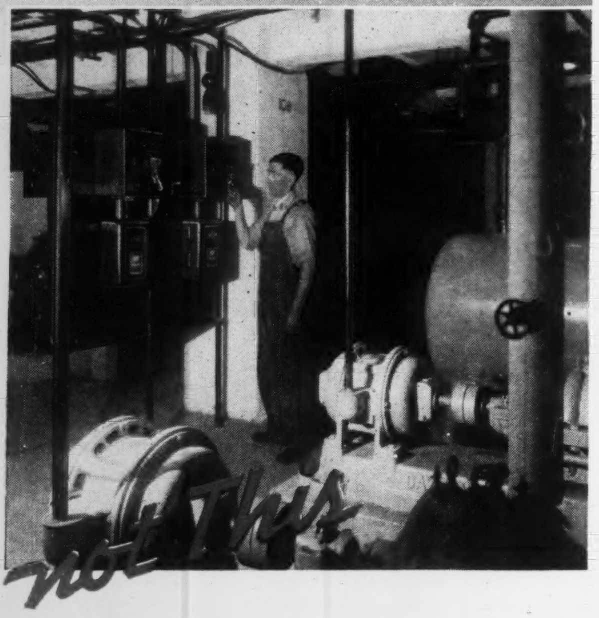

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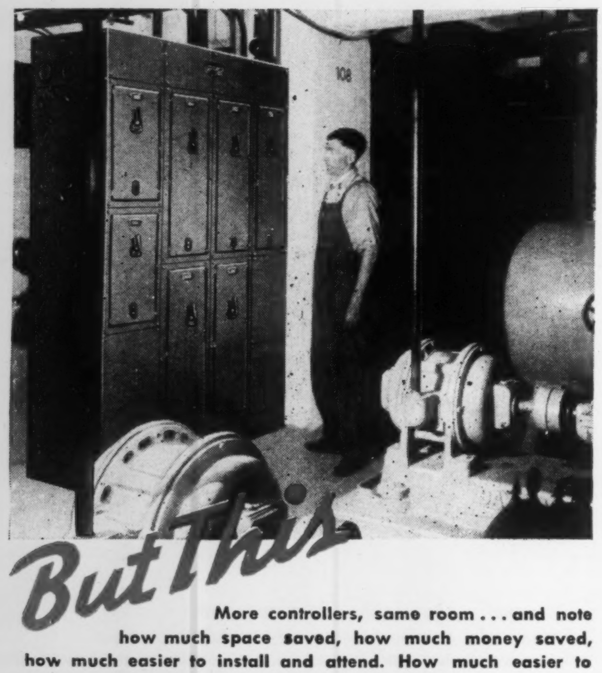

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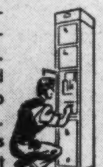

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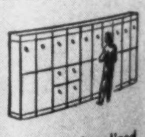
3rd... The Unitrol Control Center



A Unitrol Control Center consists of a grouping of Unitrol Sections fabricated into a complete sectionalized assembly and delivered ready for installation and use.

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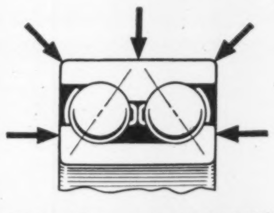


TWO JOBS — ONE BEARING

Big advantages in economy of manufacture and machine performance result from the use of the Angular Contact Double Row ball bearing *which was originated by New Departure* to resist both radial and thrust loads.

Today automobiles, trucks, tractors and machinery of many kinds depend upon bearings developed by New Departure from this original dual purpose "new departure."

MACHINE DESIGN

Hydraulic Control Affords Design Flexibility

By Christian E. Grosser

ENGINEERS in many fields of machine manufacture have in recent years introduced hydraulic power or control into their designs to considerable advantage. Foremost among these are the naval and military armament designers, the machine tool designers, builders of road equipment, shipbuilders, aeronautical engineers, and more recently the designers in the automobile industry.

Hydraulic equipment manufacturers are being called upon to an increasing degree for advice in problems for which the hydraulic approach has been suggested as a possibly simpler solution. In the majority of cases, the manufacturer of hydraulic controls and equipment can not only offer efficient solutions to the problems in question, but also can suggest improvements in other phases of the design by introduction of fluid power.

It is an unfortunate fact that the literature on the subject is as yet so highly segregated that few outside the hydraulic industry have been able to collect enough of the available material for them to obtain a sufficiently comprehensive view of the possibilities or limitations of hydraulics to employ it effectively as a tool in design of their machines.

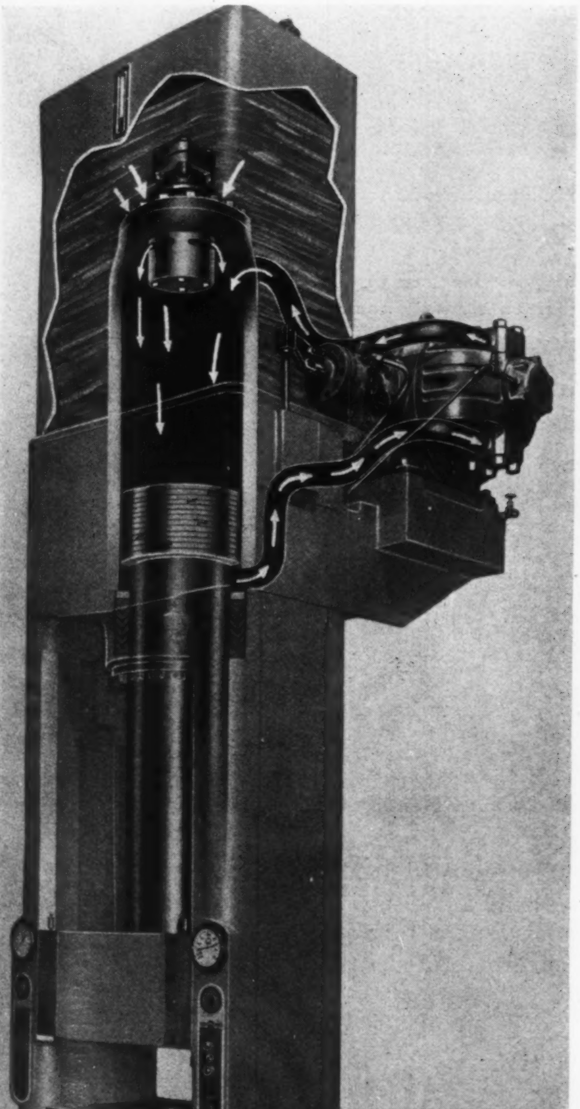


Fig. 1—Surge tank in hydraulic press permits the use of a small pump to produce high press platen speeds

The following will be an attempt not only to correlate principles underlying current hydraulic practice together with examples of their use, but also to outline a few of the important considerations which the engineer needs for preliminary design.

Restricting the discussion to positive

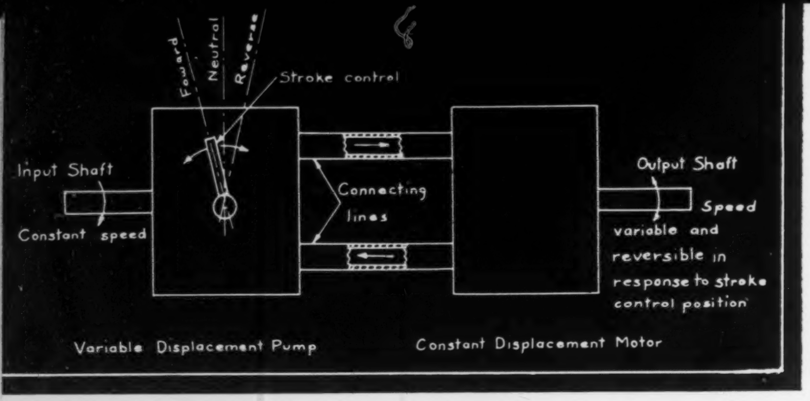

Foward
Neutral
Reverse
Stroke control
Input Shaft
Constant speed
Connecting lines
Output Shaft
Speed variable and reversible in response to stroke control position
Variable Displacement Pump
Constant Displacement Motor

Fig. 2—Simple variable speed hydraulic transmission incorporates the basic pump and motor combination

displacement units, hydraulic drives may be considered as having much the same fundamental characteristics as direct-current electrical equipment. The modern high pressure oil pump performs a function similar to that of the generator producing an electric current flow against a resisting circuit. The fluid motor is directly analagous to the electric motor. In general, fluid motors and fluid pumps are identical in much the same way as are motors and generators. The connecting circuits are strikingly similar and are susceptible to the same kind of analysis. For example, the pipes which connect the components of a hydraulic system offer resistance to liquid flow and tend to reduce pressure exactly as the resistance of the electric lines to current flow reduces potential. Electric switches, condensers, rheostats, circuit breakers, relays, vacuum tubes, find their counterparts in the various forms of hydraulic valves, accumulators, stroke controls, relief valves, differential controls and repeater devices.

Of course the analogy between the two systems cannot be carried to extremes, but it furnishes a convenient means by which the designer, familiar in principle with the properties of electrical equipment, can perceive many of the functions obtainable through the use of hydraulic power. This point of view is valuable inasmuch as the conception of power hydraulics still commonly held by a good many designers is that it consists simply of pumping oil to a cylinder, or a fluid motor, and that by valving or by a variable pumping rate, a more or less controlled mechanical motion may be obtained. This is no more completely true than that the use of any electrical circuit limits the designer only to varying the speed of motor by a rheostat.

Hydraulics Perform Many Electrical Functions

Most design engineers realize that electrical circuits may be devised to produce not only variable speeds over large ranges, but also constant torque over a considerable range of speed variation, increased torque with reduced speed, interlocking control circuits, limited power circuits, holding circuits, safety cut-out controls, torque amplification or "servo" control (which may perhaps include vacuum tubes as relays), and many others; possible principally by virtue of flexibility of the electrical control over its current.

Practically all the functions named in the foregoing can be performed by hydraulic means, since with them we have essentially the same freedom of control over a flow of liquid. It should be mentioned, however, that this comparison by no means intends to convey the impression that hydraulics should be considered simply as a substitute for electrical means.

Hydraulic equipment has greater power-carrying capacity and is capable of exerting many times larger shaft torques than electrical equipment in equivalent sizes or weights of units. The response to control is more exact in repeater or servo-mechanisms. During acceleration and deceleration cycles, inertia problems are reduced on account of smaller driving elements. On the whole, the positive displacement unit provides practically as rigid a driving means as a mechanical gear transmission with the added advantage of variable ratio changes controlled either by manual direction from near or remote locations, or by automatic direction.

Displacement equipment has been found to be most valuable in bridging the gap between mechanical drives on the one hand and electrical on the other. It cannot transmit power efficiently over as long distances nor in quite so complicated circuits as electrical equipment. Where the latter is not suitable it can and does perform a far more effective and flexible job than purely mechanical means by conveying large and variable forces or torques through distances of several feet or around many corners. Pipes in a fluid circuit may be bent more easily than shafts can be changed in direction.

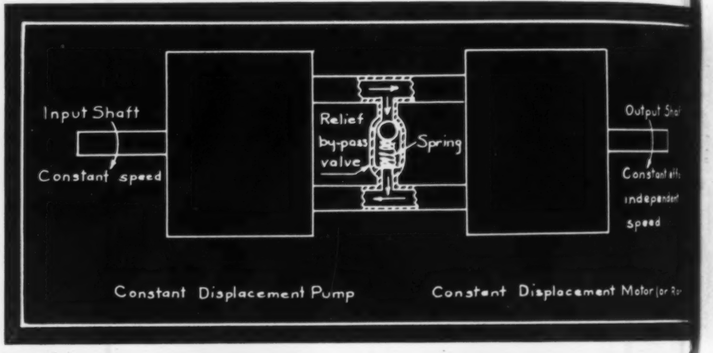
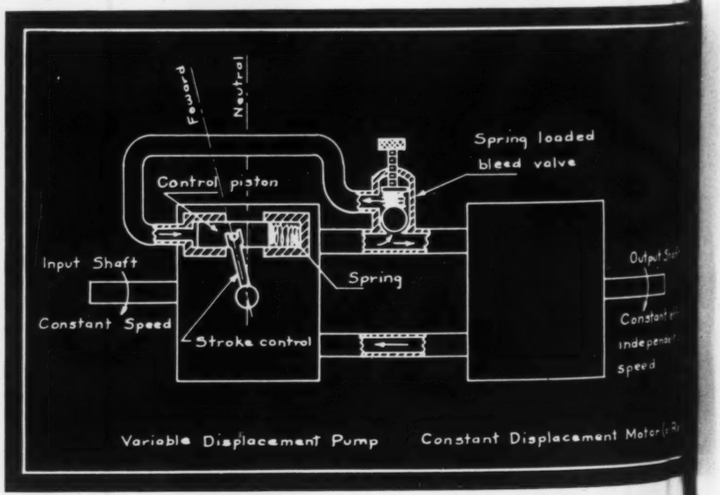

Input Shaft
Constant speed
Relief by-pass valve
Spring
Output Sha
Constant
independent
speed
Constant Displacement Pump
Constant Displacement Motor (or R

Fig. 3—This circuit produces constant torque output of a fluid motor or constant force of a hydraulic ram

Fig. 4—Constant force or torque circuit similar to Fig. 3 but higher in efficiency because of elimination of by-pass


Foward
Neutral
Spring loaded bleed valve
Control piston
Input Shaft
Constant Speed
Spring
Stroke control
Output Sh
Constant
independent
speed
Variable Displacement Pump
Constant Displacement Motor (o

The efficiency of hydraulic power units is very nearly identical with electric motor and generator efficiencies. A complete transmission with all controls will operate with about 80 to 85 per cent efficiency at full torque (or force, or pressure) and at full speed. At lower torques and speeds, efficiency drops off gradually to approximately one-third load, and more rapidly at lesser loads.

Speeds vary from a maximum of approximately 2000 revolutions per minute in small fractional horsepower units, down to 200 to 300 revolutions per minute for machines capable of transmitting several hundred horsepower.

To fill in this brief outline of hydraulics' position in the general picture of design, and to illustrate a number of the functions suggested above, the following discussions of typical circuits are offered, together with the characteristic operations performed.

SIMPLE VARIABLE SPEED TRANSMISSION: In its most elementary form this circuit employs only a pump, connecting lines, and fluid motor as illustrated diagrammatically in *Fig.* 2. The fluid motor is normally but not necessarily of the same size and same construction as the pump. Usually the pump may be variable in displacement with a manual control so that motor speeds may be chosen anywhere from full pump speed in one direction, down to standstill, and up to full pump speed in the opposite direction. If the fluid motor is made half as large in displacement as the pump, its maximum speed will be twice that of the pump. This property of inserting a speed ratio by differing volumetric displacements between pump and motor can often be used to avoid introducing otherwise additional mechanical speed changes into a design.

> *INCREASED use of hydraulic control warrants the attention of engineers to the basic operating circuits analyzed in this article, the first of several on hydraulics in machines. The author, for many years an engineer with a prominent manufacturer of hydraulic equipment, is now a member of the faculty of the Massachusetts Institute of Technology*

In addition to the primary elements of pump and motor, safety relief valves are invariably included in this and more complicated circuits to protect the system against overload. An oil storage tank is always an essential to permit oil expansion and to catch leakage. Replenishing (leakage make-up) valves or their equivalent must be included to return leakage oil (that has leaked past clearances) into the low pressure side of the pumping system. Oil leakage causes a slight loss from the theoretical speed of the fluid motor—usually not serious enough to consider. For continuous duty, oil pressures approaching 1000 pounds per square inch may easily be maintained. For intermittent duty periods, of short duration, pressures in the neighborhood of 2000 pounds per square inch are not uncommon.

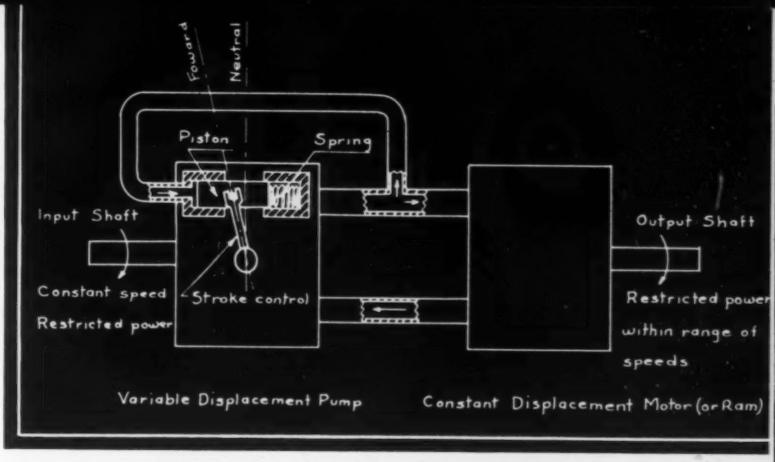


Fig. 5—Used when a speed reduction must accompany a torque increase, this circuit is adaptable to many power functions of driven load speed

This simple basic circuit has been and still is extensively used to provide stepless speed regulation for conveyors, steel and paper mills, winding reels, lathe spindles, boring mills, hoisting machinery, gun turrets and printing presses. An automotive drive of this kind to replace the ordinary change speed transmission has also been successfully used although it has been considered too expensive for automotive manufacture.

Gives Variable Translatory Motion

By the substitution of a hydraulic cylinder ram in place of the fluid motor, variable translatory motion may be obtained. Such an arrangement is found on grinder and planer tables, broaches, hydraulic presses, drill slides, shapers, slotters, and various machine tool feed mechanisms.

A further variation of the circuit replaces the variable displacement pump with a simpler constant flow pump, together with a metering valve. Whatever oil is not passed through the metering valve is by-passed

Fig. 6—Compact installation and facility of control typify printing press drive

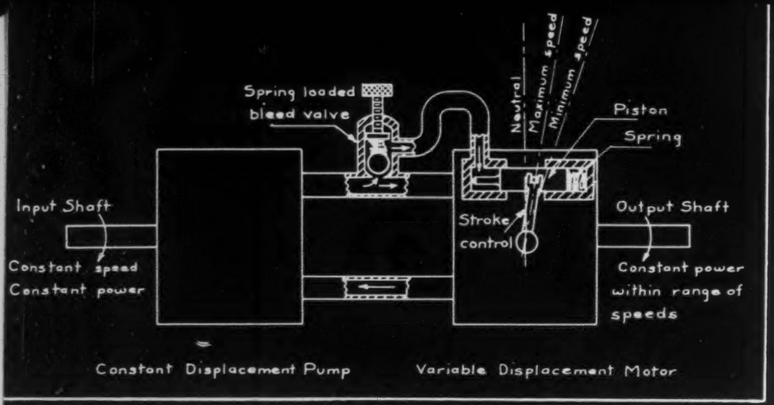


Fig. 7—Given bleed valve setting results in constant power output over a wide speed range

through a pressure relief valve and returned to the suction side of the pump. The metering valve adjustment may be used in exactly the same way as the stroke adjustment of the variable displacement pump, to vary fluid motor or cylinder ram speeds at will. This latter arrangement is common in machine tool applications because of its low initial cost. Its efficiency is poor on account of the by-passed high pressure oil, but efficiency in small power units is secondary consideration.

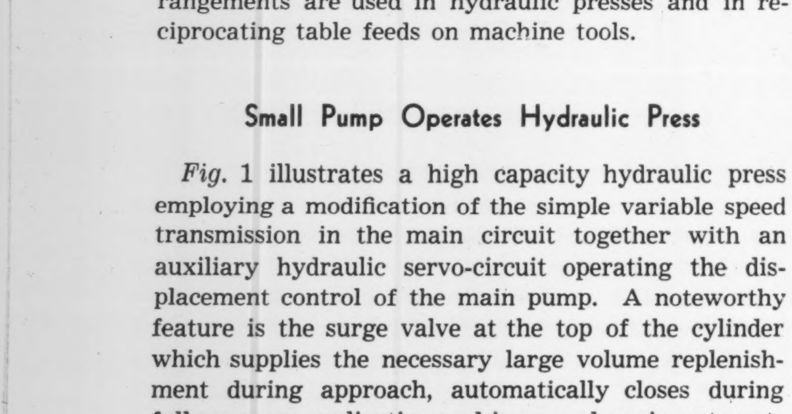
In many instances of the simple variable speed drive with a hydraulic ram, the pump stroke control or control valve may be reversed automatically at the end of the ram stroke either by a mechanical limit link or an auxiliary hydraulic control circuit set into operation by the ram to reverse the flow of oil. Such arrangements are used in hydraulic presses and in reciprocating table feeds on machine tools.

Small Pump Operates Hydraulic Press

Fig. 1 illustrates a high capacity hydraulic press employing a modification of the simple variable speed transmission in the main circuit together with an auxiliary hydraulic servo-circuit operating the displacement control of the main pump. A noteworthy feature is the surge valve at the top of the cylinder which supplies the necessary large volume replenishment during approach, automatically closes during full pressure application and is opened again automatically for the return stroke. This arrangement permits high rates of approach and return with a relatively small displacement pump.

Torque and Force Limiting Circuits: Where it is desired to operate a fluid motor or ram with a restricted and constant amount of effort so as to allow the output speed to accommodate itself to load movement or to synchronize speeds with another machine function, two variations of the simple variable speed circuit are used. In the first the constant displacement pump produces a uniform flow in excess of that required for the highest speed of the load as shown in *Fig.* 3. A by-pass relief valve then permits the excess oil to flow out of the system. Pressure is maintained at a constant level against the hydraulic ram or fluid motor and consequently a clamping at rest function, or a follow-up function at speed may be performed at any load speed up to the maximum.

Fig. 8—Torque amplifier or servo-circuit provides precise positioning in response to control signal



Variable Pump Improves Efficiency

In another form, shown in *Fig.* 4, the circuit employs a variable displacement pump with automatic pressure-holding stroke control. This consists simply of a spring tending to augment the flow of the pump by acting to increase its displacement. Acting to oppose the spring is a pressure-operated piston connected to by-pass valve bleeding high pressure from the connecting power pipe line. The arrangement results in only as much oil being pumped as is necessary to maintain constant pressure in the line.

Such constant effort and pressure-maintaining circuits are used in rolling mill drives, where synchronization of roll speeds is important, constant tension reels, clamping circuits of hydraulic presses, injection circuits in plastic molding presses, broach pullers and auxiliary power circuits in aircraft to supply landing gear retraction cylinders, etc.

Power Restricting Drives: Often it is desirable to obtain a driving effort which carries a definite relationship to the driving speed. Most frequently this takes the form of a constant horsepower output such that the fluid motor torque varies inversely as its speed, or a hydraulic ram exerts a force in inverse proportion to its speed of advance. However, almost any function of power against speed may be obtained with the circuit.

Power Is Constant Over Speed Range

The variable speed circuit is again used as a basis. Either pump or motor must be of the variable displacement type. The remaining unit is of fixed displacement. (If a ram is used as a motor, the pump must necessarily be the variable element.) With the variable pump method illustrated in *Fig.* 5, a spring is again applied to the displacement control tending to increase displacement. A piston actuated directly by pressure from the power pipe line opposes the spring action on the control. The net effect is to maintain a relationship between volume of oil pumped and the pressure applied to the motor element. This is to say that a power function of speed is prescribed. If the pressure and volume rate are maintained in inverse ratio, the power remains at a constant level within certain practical limits of output speed.

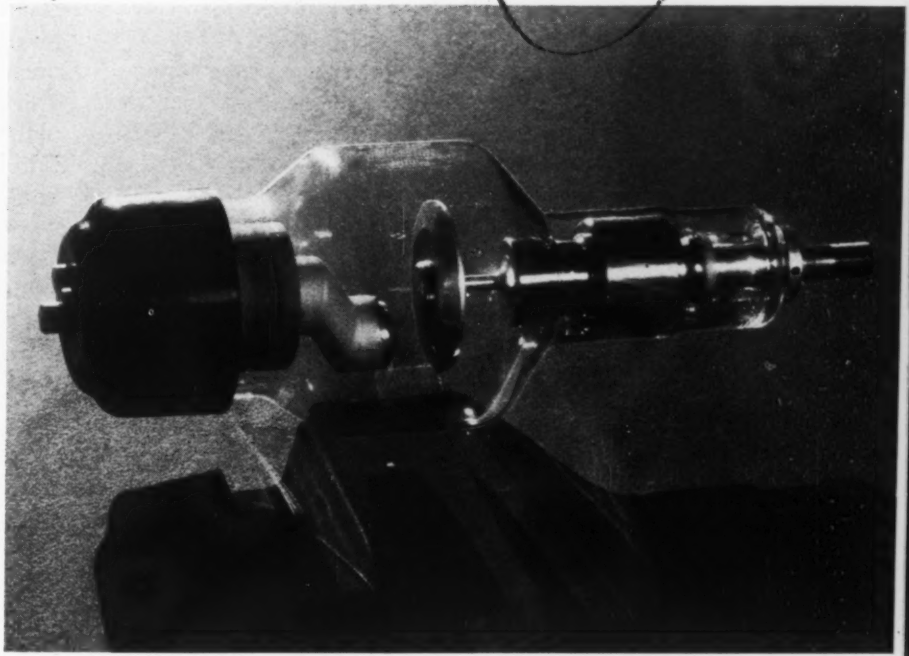
When the fluid motor is the variable element, as in

(*Continued on Page* 120)

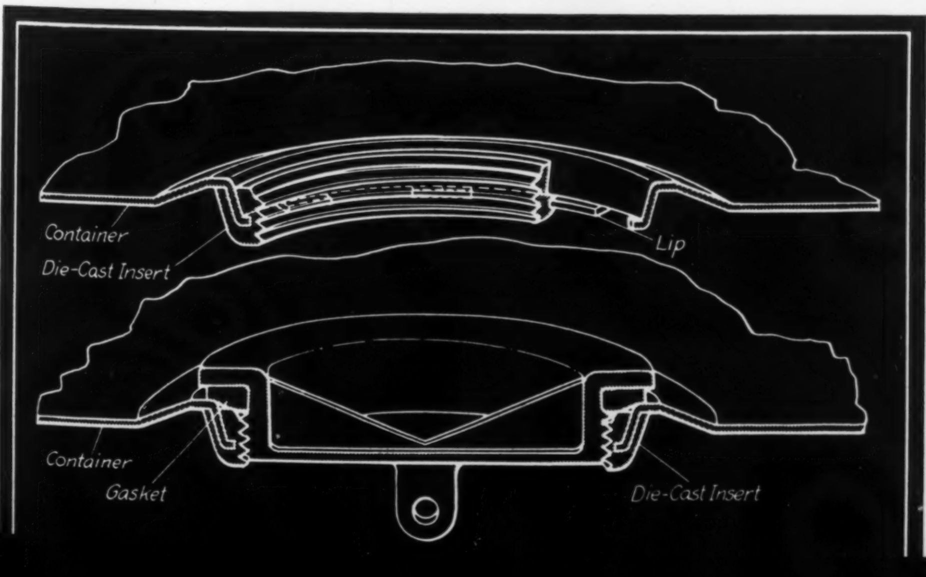
Scanning the Field FOR IDEAS

Barium film as a lubricant where organic lubricants are undesirable is utilized in the high vacuum tube illustrated. Vaporizing metallic barium to place a film on the steel ball bearings of the rotating target greatly reduces the friction in this General Electric X-ray tube, providing quieter operation and longer life.

Under the normal operating temperatures of the X-ray load, the film will effectively lubricate an anode bearing for 50 to 100 hours of rotation. Use of barium film reduced the sound level of operation from 87 to 68 decibels and allowed increase in speed from 3100 to 3560 revolutions per minute. Other practical films with lubricating properties are chromium, aluminum, magnesium and zinc in air.

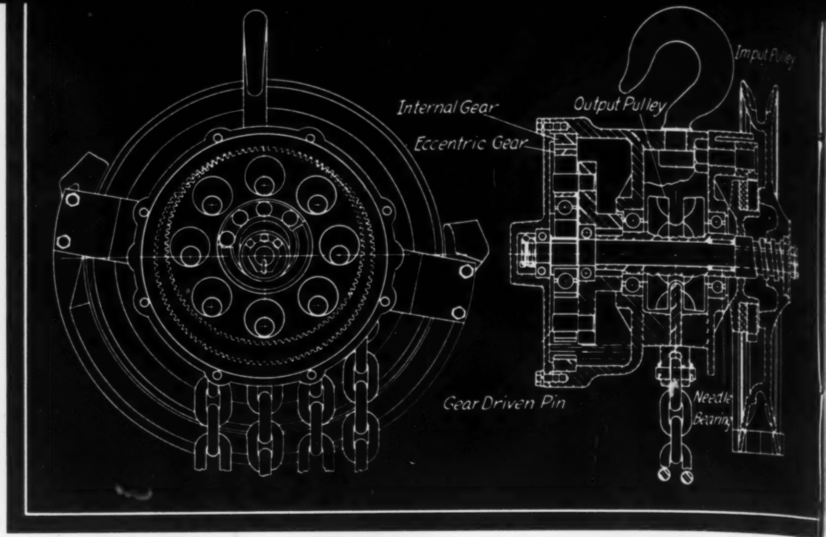


Cast-on flanges as shown in the drawings eliminate relatively complicated assemblies such as metal rings and gaskets pressed on in the manner of a grommet. Used on metal containers the flange inserts, designed by United Steel Barrel Co., are zinc alloy die castings. A hole in the container is previously punched to form a serrated hook-like lip and the alloy forming the flange is cast around it as shown. Provisions against any possible leakage between casting and container are secured by having the gasket of the sealing plug seat against the sheet steel body of the container itself.

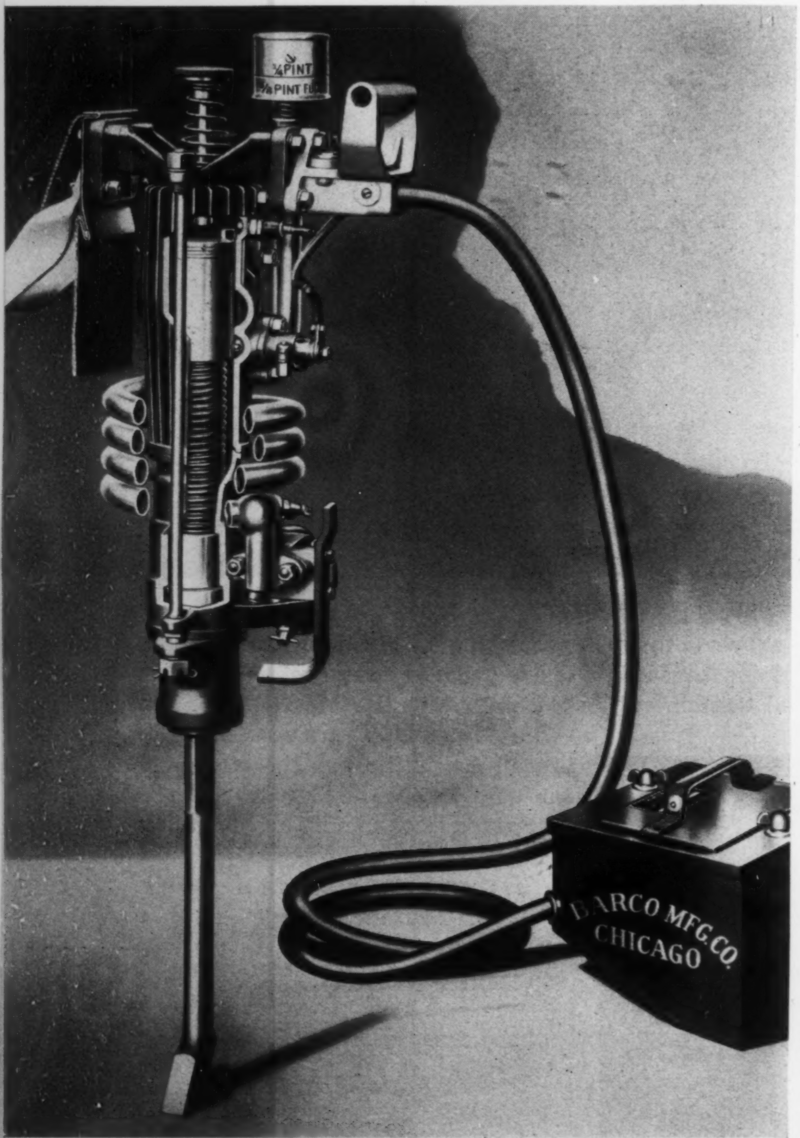


Cam actuated gear reduction designed by Coffing Hoist Co. is irreversible, especially compact and has a high mechanical advantage. As shown in the drawing at the right, the input pulley drives a shaft through a quill on which is mounted the output pulley. The shaft is supported effectively at the right end by a needle bearing and at the outboard side by a ball bearing mounted in the end bracket. An eccentric keyed to the shaft drives a spur gear to mate with an internal gear integral with the housing.

Providing concentricity of its driven members, the spur has eight holes equally spaced with diameters equivalent to the eccentricity plus the diameters of their fitted pins. These pins are on a flange keyed to the quill. In this way the system is doubled back to produce a compact and efficient high reduction unit.

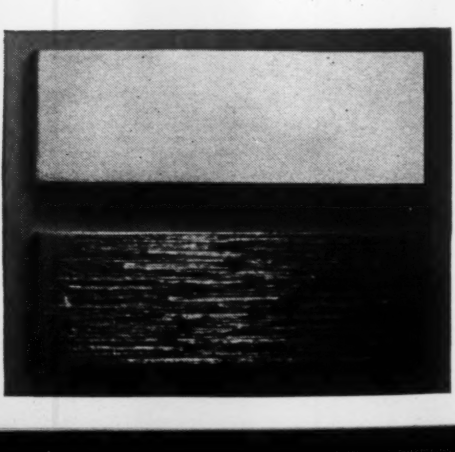


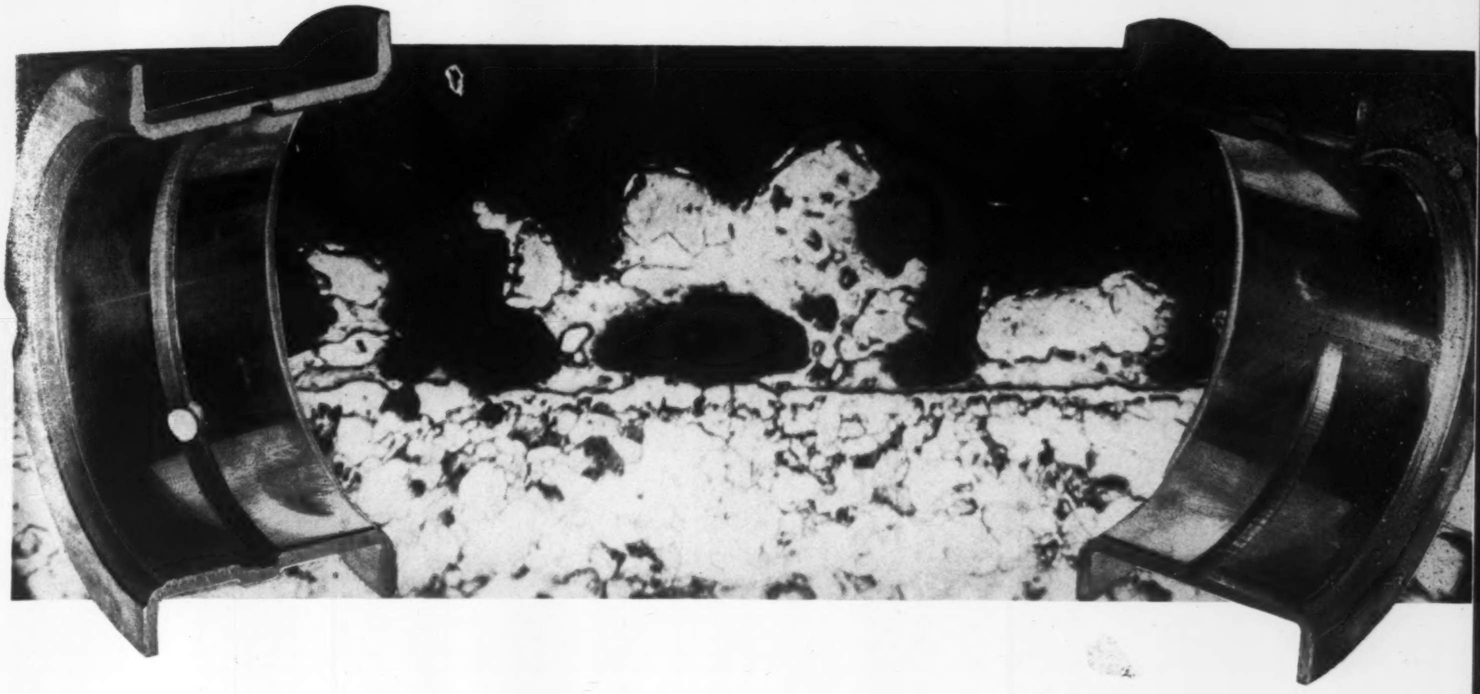
Crankless engine drives portable tool, left, consisting of a single-acting two-cycle engine. Explosion of gasoline in the combustion chamber drives the piston downward, striking an anvil to transmit the power stroke to the work head. Piston is returned by a helical spring having characteristics which determine the frequency of the power strokes, approximately 1300 per minute. There is no stalling load on this design and virtually the only wearing parts are the piston and cylinder walls. Designed by Barco Mfg. Co., the unit is started by two downward pushes on the starter button on the cylinder head. The first draws a charge into the lower part of the cylinder. The second allows the mixture to flow into the combustion chamber for ignition and the engine starts.



Surface hardness and wear resistance can now be coupled with the strength, toughness and corrosion resistance of stainless steel. In effect a new material, it achieves these properties through a new nitriding process developed by the Drever Co. The wear test specimens below tell in a concise form what may be expected of nitrided stainless. Upper test piece is hardened 18-8 stainless and was subjected to six times the number of strokes in a wear machine than was the bottom piece of untreated 18-8.

Hardnesses up to 1050 Vickers Brinell are secured by this process. For straight chromium grades case depths up to .028-inch are obtainable. Chrome-nickel types can be surface hardened to depths up to .01-inch.



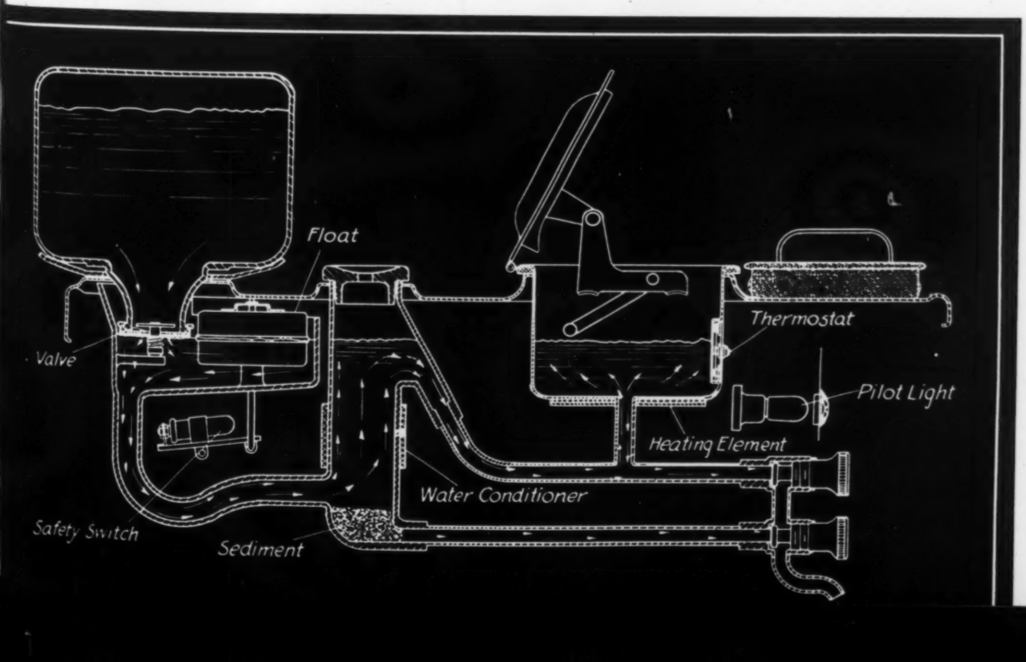


Increased bearing pressures are permitted and longer life provided by a newly developed process utilizing a thin layer of babbitt on a powder metal matrix bonded to a steel back. Bearing alloy is high-lead corrosion resistant composition containing 92 per cent lead. The matrix is a sintered mixture of copper and nickel applied to the steel back of the bearing. This durable bond is porous and provides an excellent bond both metallurgical and mechanical in nature. The structure is visible in the accompanying micrograph at 75 diameters enlargement. Dark area is babbitt and the solid section shows the copper layer of the steel back. Matrix with its interlocking pores and voids is immediately above the steel back.

Developed by Buick in co-operation with Moraine Products Division of General Motors, the bearing is able to withstand pounding and high loads due to a preloading process. The bearing with its bonded matrix is squeezed between a set of large rolls which compress the matrix under loads of 10,000 pounds per square inch, achieving a still porous, preloaded structure capable of carrying several times the greatest load found in normal engine operation.

Automatic operation is provided by refinements and safety features on the sterilizer shown in the diagram. Designed by Ritter Dental Manufacturing Co., Inc., the unit maintains a constant water level by utilizing the principle of the well-known bottle-type water cooler. A valve on the black glass bottle prevents spilling during handling, but opens on engagement of plunger against a stop in the water chamber.

As long as some water remains in the bottle, the level in the sterilizer is constant. Should the level fall when the reservoir becomes exhausted the float switch operates a mercury switch and disconnects the unit. Other features include a trap for preventing heating of the reservoir, electric heater to initially remove sediment from the water before reaching the sterilizer, thermostat control of heat and ample provisions for cleaning.



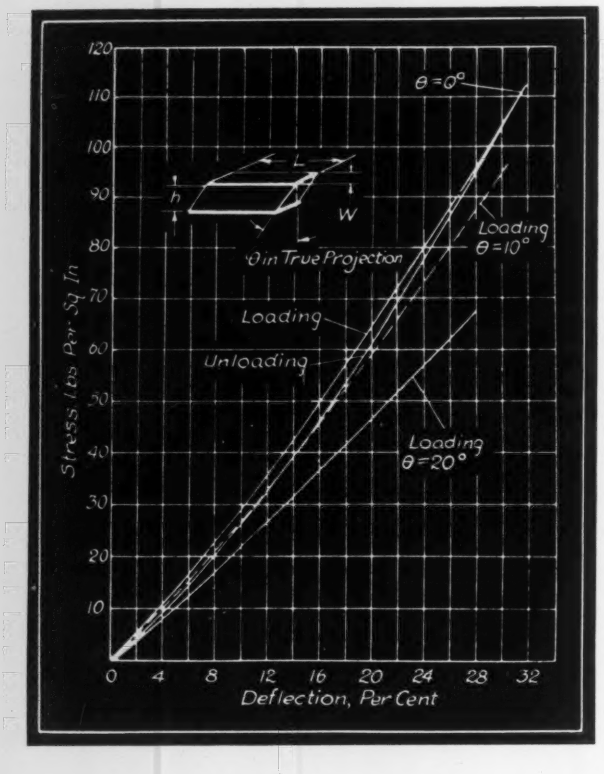


Fig. 1 — Load - deflection curve for compression loading of rubber shear pad of 36 durometer hardness. Angles of theta increase from zero to 20 degrees

How Rubber Defl

with She

By J. F. Downie Smith

United Shoe Machinery Corp.

COMMON practice when using rubber pads in shear is to subject them simultaneously to compression. The value of the compression is ordinarily from 5 to 10 per cent of the free thickness of the rubber, and before shear stress is applied it is customary to have a shape something like that shown in *Fig.* 1. Depending upon conditions, the angle θ would vary with the shear load.

A question which might arise is: "With varying angles of θ, what would be the effect on the compression load-deflection curve?" This can be investigated in several ways. One would be to vary the angle θ, always maintaining the same length, width and height of the piece. It is clear that with one length, one width and one height of the rubber, a piece with the angle θ greater than zero would give greater deflec-

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Presented by the Rubber and Plastics subdivision at the annual meeting, ASME.

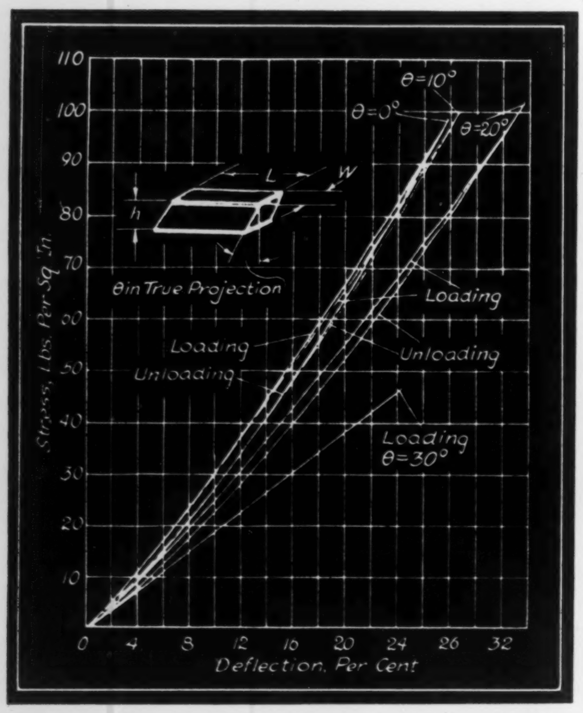


Fig. 2—Load-deflection curve for same kind of pad as in Fig. 1, except that angles of theta decrease from 30 degrees to zero. Width, height constant

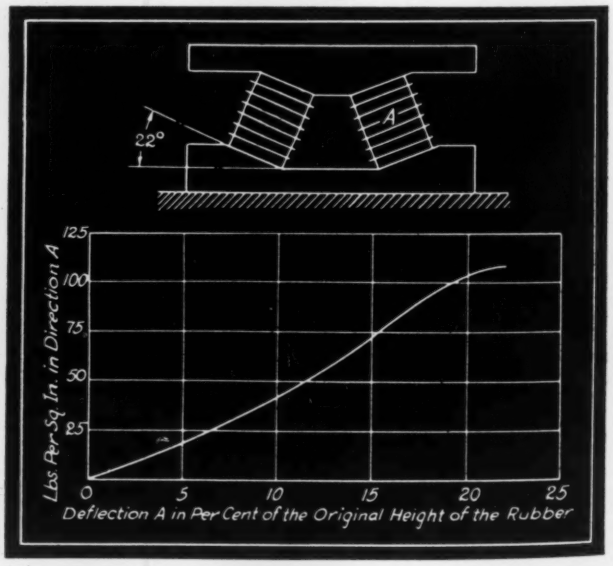
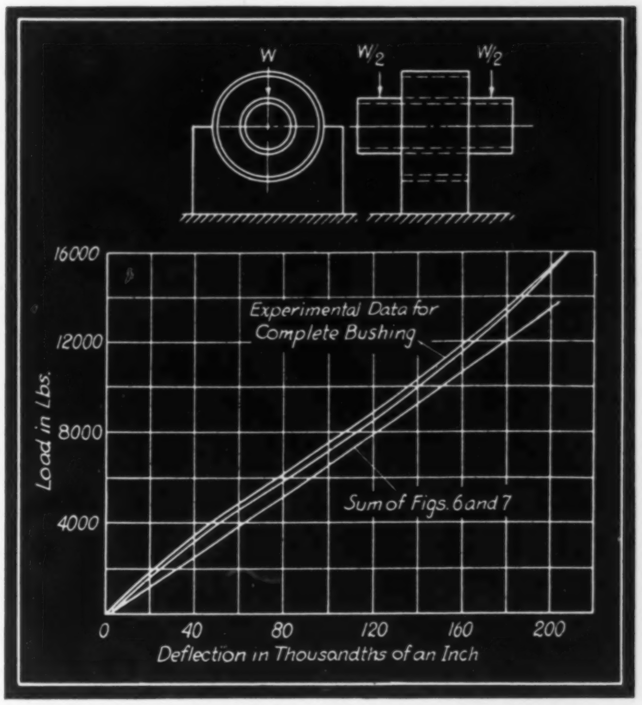


Fig. 3—When perforated slabs were placed in two groups of seven each at an angle of 22 degrees, instability crept in after 18 per cent deflection

Fig. 5—Inner cylinder of torsion rubber bushing was loaded relative to the outer, which was maintained in a fixed position. Various stresses then appeared



Deflection Varies

Shear Angles

tion under a compression load of a certain amount than a rectangular block with the same dimensions.

This particular method, in experiments, is inconvenient, and instead a constant width and height were maintained, starting with a rectangular block of a definite length. From this block duplicate wedge-shaped sections were cut from each end thus decreasing the length, and the load-deflection curve was again obtained. The experiment was repeated for several different angles of θ up to 30 degrees. After the block with this angle removed had been tested, the angle was decreased by cutting wedges in the reverse manner from the piece until the angle was reduced to zero. The second set of curves obtained with various angles is shown in *Fig.* 2.

Several interesting facts were obtained during these tests, all of which were performed with rubber vulcanized to metal. Among the most important are the following:

1. *Figs.* 1 and 2 show that at a stress of 100 pounds per square inch and angle zero, the deflection with the

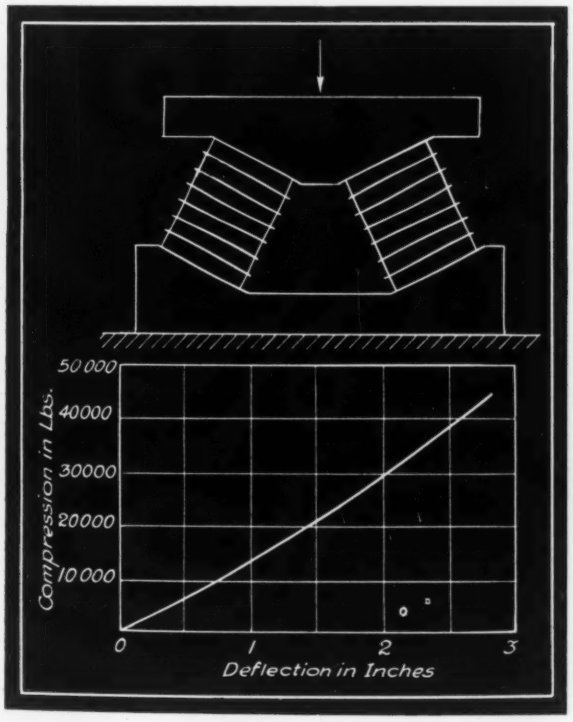


Fig. 4—After guide pins were placed in four holes, no instability appeared up to 24 per cent deflection

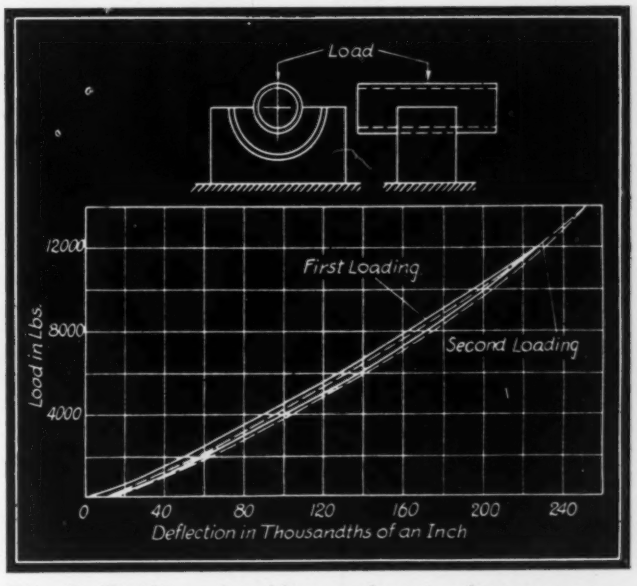


Fig. 6—Rigidity of rubber under simultaneous compression, tension and shear is hard to calculate, but this is deflection for half of bushing, compression loaded

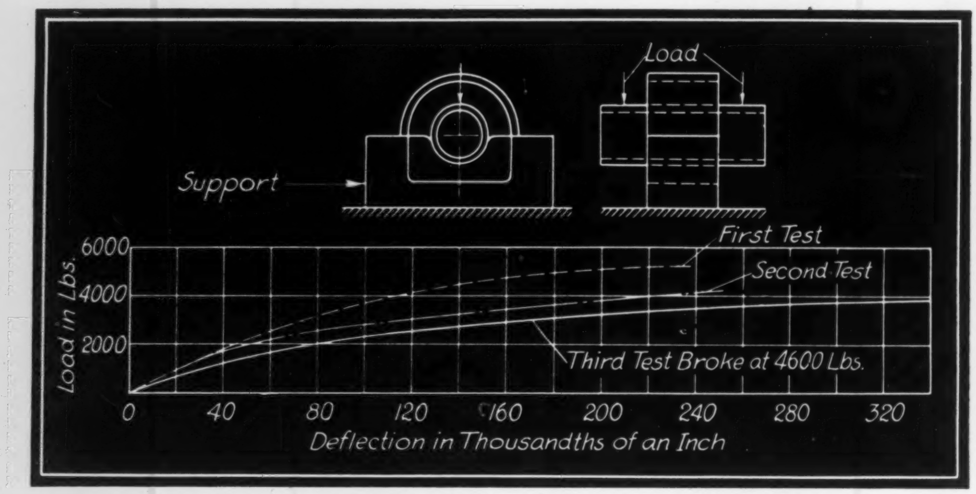


Fig. 7—Turned upside down, the bushing used in Fig. 6 was loaded in tension, with these results

initial block was 28 per cent, whereas with the final block, which was a little more than one-quarter the original length, the deflection was 29 per cent. Thus the influence of length over this range was not great. Such close agreement is not obtained with angles of θ greater than zero. For example, when θ is 20 degrees the stress is 60 pounds per square inch and the deflection with the larger block is about 21.5 per cent, whereas with the smaller one it is found to be about 25 per cent.

2. A second important point involves the first statement that no great change in deflection based on a definite compressive stress applied to the plates takes place over a wide range in length. From *Fig.* 1 it can be seen that a shear pad starting with an angle θ of 30 degrees and a compression of 20 per cent, would have a lateral compressive force of 38 pounds per square inch. When this pad is loaded in shear, however, until the angle θ is 0 degrees, for the same compressive deflection the compressive stress is now 67 pounds per square inch, or an increase of 76 per cent over that originally applied. For still larger initial angles of θ than 30 degrees (and 45 degrees is common in industry) it would be expected that still greater compressive stresses would be encountered. This fact naturally is of importance when designing housings for the shear pads.

Direct Measurement Desirable

The foregoing conclusion is based on indirect readings, of course, and verification by direct measurement would be desirable. Such measurements would involve the determination of compressive stresses as the shear loads are increased from 0 to maximum.

A possible explanation of this phenomenon can be gained if we assume that the rubber consists of an infinite number of rubber columns, each one alike and all parallel. As the angle θ is decreased with constant height, the length of each element decreases, so that the compressive force necessary to maintain height is increased.

In contrast to this effect it is known that if a double shear pad is loaded centrally with small initial lateral compression, under full load the slabs tend to leave the supporting walls at the top, indicating a decrease in compressive force at this point as the shear stress increases. If the previous conclusion regarding the increase in compressive stress is correct, it must be that the increase in compression at the bottom of the shear pads is much greater than would be expected at first glance. Further experiments on this particular subject might yield interesting results.

3. The effect of increasing angles θ on the compressive stress-strain curves is not linear. Small angles play little part whereas larger angles have more effect than would be obtained from direct proportion to the smaller angles.

4. If the effective area is considered to be $W\ (L\text{-}h \tan \theta)$, then the curves all come much closer together, showing that the end piece, of length $h \tan \theta$, plays little part in the resistance to compression.

Compression Pads Perforated

For relatively large deflections, compression pads are often perforated. A single slab of this construction was tested in the laboratories of the B. F. Goodrich Co. and seven of them were mounted in series in the laboratories of the E. G. Budd Mfg. Co. Load deflection curves were obtained in both cases. Up to about 20 per cent deflection, the curve for the single slab agrees with that for the seven slabs, as expected. Further increase in load, however, caused the deflection of the seven to increase more rapidly than that of the single slab. The reason for this increase can be definitely given as instability. To check this conclusion the same slabs were mounted with four guide pins to prevent side movement of any slab, and curves again obtained. Instability was not evident even up to 24 per cent deflection.

Thus care must be taken where large deflections are to be obtained either to keep the total height of the slabs small compared with the linear dimensions of the loaded area or to provide a guide for the slabs to improve stability.

These slabs were then placed in two groups of seven each at an angle of 22 degrees to the horizontal, as shown in *Fig.* 3. It can be seen that after some 18 per cent deflection, instability crept in. When guide pins were placed in four of the holes and the experiments repeated, this instability had not appeared up to deflections of 24 per cent, as can be seen clearly in *Fig.* 4.

Although torsion rubber bushings are becoming popular, occasionally they are used where no provision is made for insuring concentricity. Thus a torque arm may be applied to either the inner or outer metallic bushing and unless this torque arm is equalized, a load can be applied to the rubber perpendicular to the axis. In order to find the radial deflections to be expected with a particular sample of rubber bushing, the experiment shown in *Fig.* 5 was performed. The inner cylinder was loaded relative to the outer while the outer one was maintained in a fixed position.

Stresses of Various Types

With such loading conditions the stresses in the rubber are of various types. At the bottom the stress is compression; at the top, tension; at the sides, shear; and at other points, combinations of these would be expected. Unfortunately, the rigidity of rubber under all three conditions would be extremely difficult to calculate.

To get a rough figure for the relative importance of the stresses, the bushing was cut in two and the lower half loaded in compression as shown in *Fig.* 6. The bushing was then turned upside down and this same half bushing loaded in tension as shown in *Fig.* 7. For a given deflection, the sum of the half bushing loaded in compression and the half bushing loaded in tension was obtained and a curve plotted on *Fig.* 5. This does not quite check the original curve so that the two cannot be considered independently of each other.

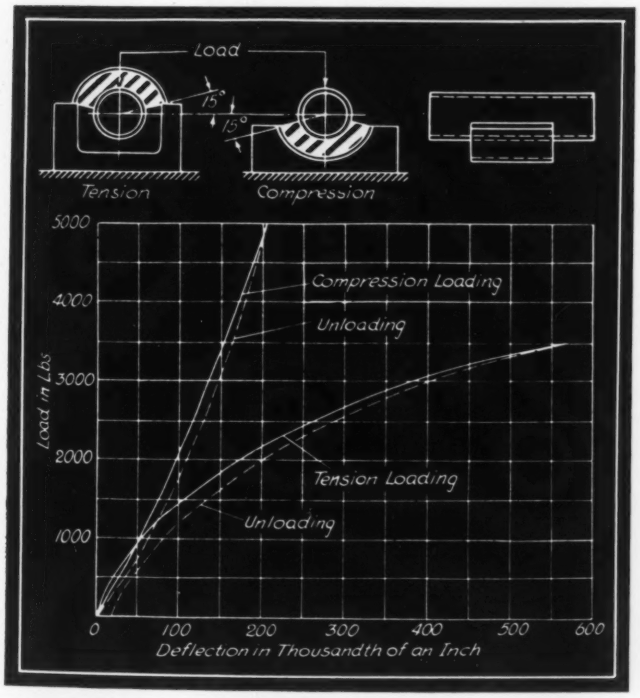


Fig. 8—To determine roughly how effective each part of the bushing was in withstanding load, 15 degrees were removed from each side of half bushing

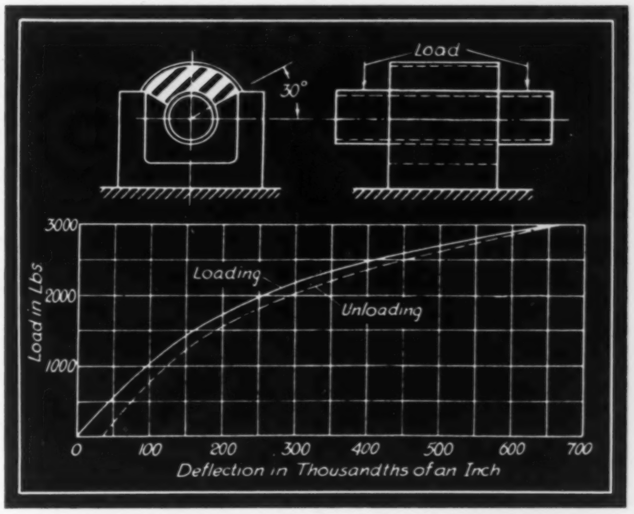


Fig. 9—Fifteen more degrees were cut from the piece used in Fig. 8, and this curve was obtained for a piece loaded in tension only. Load of 1050 pounds is carried

Over most of the range in *Fig.* 5, the slopes of the curves are quite similar. In order to determine roughly how effective each part of the bushing was in withstanding tension and compression, the bushing was cut still further, as shown in *Figs.* 8 and 9. It will be noticed that under a static deflection of .2-inch the half cylinder maintained a compression load of about 10,000 pounds (*Fig.* 7). When 15 degrees had been removed from each side (*Fig.* 8) a deflection of .2-inch was obtained with a load of 4800 pounds, although only one-sixth of the rubber had been removed from the half cylinder.

Side Parts Resist Radially

Comparing *Figs.* 7 and 8 for tension values, for the same rubber reduction of one-sixth, at .1-inch deflection the load is reduced from approximately 2400 pounds to 1450 pounds. Thus the influence on resistance to radial movement of the side parts of the bushing is quite appreciable.

Continuing the test in tension the data in *Fig.* 9 were obtained. For .1-inch deflection a load of about 1050 pounds is carried, although only one-third of the half bushing has been cut away. Unfortunately, this part of the bushing was damaged at the completion of the tension test so that the compression curve was not obtainable.

Some of the experimental data were obtained in the laboratories of the E. G. Budd Mfg. Co. by D. Burkin, R. J. Lee, and F. Heinze, and the author appreciates the co-operation of the company in the work discussed in this article.

We have purchased, or have on order, over $450,000 of new machinery. We are buying this machinery with our own money, that is, not refusing to start until the government finances us.—James S. Knowlson, president, Stewart-Warner Corp.

Combining Advantag

By James J. Kux

Kux-Lohner Machine Co.

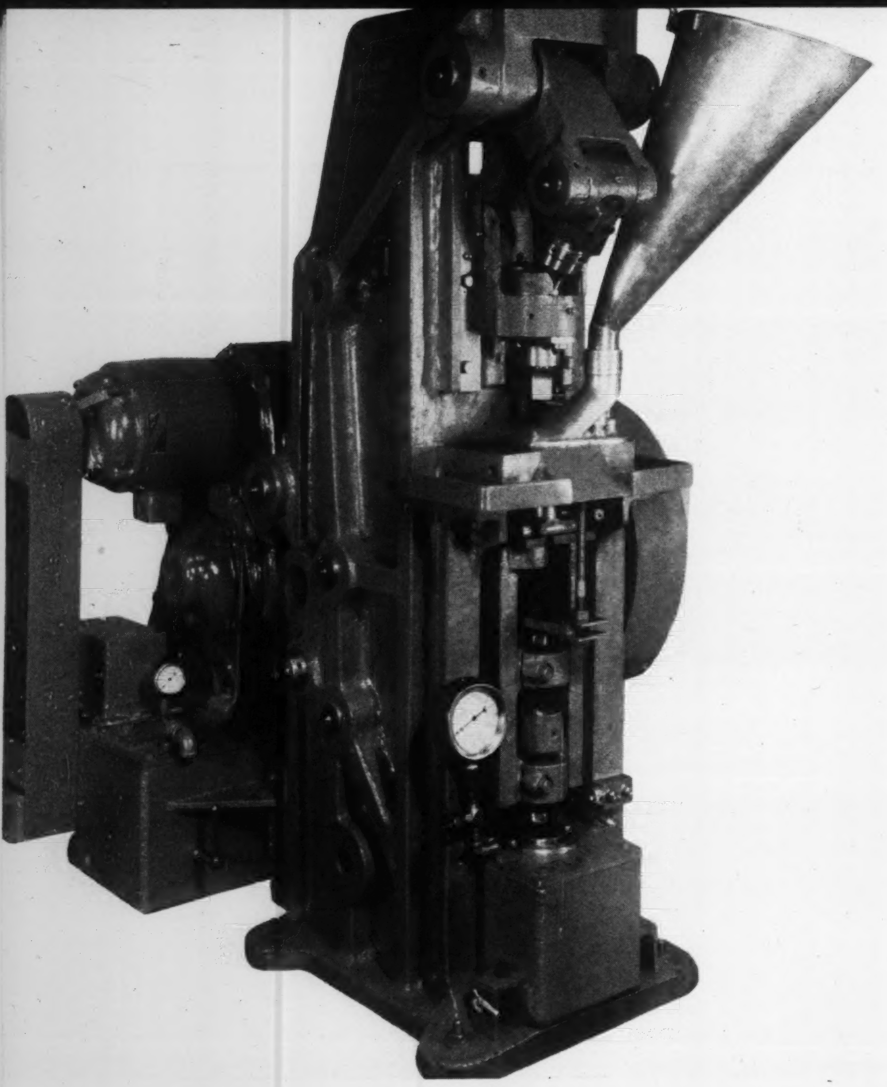


Fig. 1—Definite hydraulic pressures and speed of mechanical actuation are combined in the operating cycle of tablet press

HYDRAULIC operation in forming and compressing loose powdered materials into solid compacts or tablets has the distinct disadvantage of being slow in production. On the other hand, mechanical presses—however fast and automatic—do not apply positive and uniform compressing pressures, a necessity in forming many types of compacts. Examples of such compacts are electrical contacts and plates used in high frequency electrical controls formed from powdered metals having high melting points, such as tungsten, silver, platinum and molybdenum. Carbon brushes and resistors formed from graphite and carbon material are others.

The need for a machine combining the definite, unvarying compressing pressures of a hydraulic press with the high speed, automatic operation of a mechanical press has brought about the development of the combined mechanical-hydraulic tablet press illustrated in *Fig.* 1. To indicate the design relationship between the various parts of the machine, a brief discussion of its operation follows.

Mounted in a die table at the front of the machine, a die receives a charge of the powdered material from a feeding shoe actuated through a link and cam, *Fig.* 2. Forming the bottom of the die, a plunger or punch is mounted on a carrier which rides in V-gibs similar to those used on milling machines. This punch carrier is adjusted by a screw to increase or decrease the height of the lower punch in the die, thus controlling the amount of material filled into the die.

When the feeding shoe has filled the die with its charge of material, the link and cam action sweeps the shoe out of the way of an upper plunger or punch, wiping off all excess material from the die surface. This upper punch, mounted to an upper carrier also riding in V-gibs, is actuated by a mechanically-operated toggle linkage, shown in *Fig.* 2. It enters the die to compress the material partially and then comes to a positive stop.

At this point the hydraulic unit comes into play. As the upper punch reaches the end of its stroke a valve is automatically tripped. This causes the hydraulic ram to rise, applying a predetermined pressure on the lower punch carrier resting upon the ram. This forms the partially compressed material into a solid tablet. When the desired, previously adjusted pressure is reached, the ram returns to its normal position. Completing the cycle of operation, the upper punch travels upward out of the die. In time with it, a mechanically-operated lower lever contacts the lower punch carrier, *Fig.* 2, to eject the compressed tablet from the die. Stroke of this lever and its travel is timed slightly behind the upper punch so that there is no interference between the tablet being ejected and the punch.

Relieves Cams of Heavy Duty

Mechanical functions and timing of the machine are all controlled by hardened steel cams mounted on one camshaft, *Fig.* 2, and housed inside a one-piece steel main frame. Double back gearing is interposed between the flywheel and camshaft. Each cam has a separate duty to perform, and is accurately timed in relationship to the others.

Since the full pressure load of the machine is applied by the hydraulic unit, all cams are relieved of heavy-duty work. This increases their wearing life immeasurably. Notwithstanding, all are face cams except the feeding shoe cam which of necessity is a groove cam. Replaceable sections are bolted on the high spots or rises, which are subjected to the great-

tages of Hydraulic and Mechanical Operation

est wear resulting from positive acceleration.

The toggle which actuates the upper punch carrier is operated through a connecting link by one of the cams. When the upper punch is down at the end of its stroke, the toggle is closed on dead center and in this position takes the full hydraulic pressure applied by the lower punch. As soon as the hydraulic pressure of the lower punch is relieved, the toggle breaks and brings up the upper punch carrier. Wide bearing surfaces employing heat-treated, alloy steel pins operating in hardened steel bushings assure long life of the toggle mechanism.

Lower punch carrier is an oblong-shaped steel casting operating in its adjustable V-gibs. The lower punch held in a flange type punch holder is securely mounted to the top section of this carrier. The upper punch carrier is linked to the toggle arm by a ball and socket connection, *Fig. 2.* Pressure stroke of the punch is increased or decreased by a simple adjustment of this link.

An outstanding design feature of the machine is the use of an extension of the main frame for supporting the die table. Thus all pressures applied within the die are partially absorbed by the main frame itself. The die, constructed with a groove around its outside diameter, is held securely in place in the die table by tapered lock pins. These lock pins, extending through holes in the side of the table, are jammed against the groove in the die, and firmly held by set screws.

Hydraulic functions of the machine are obtained

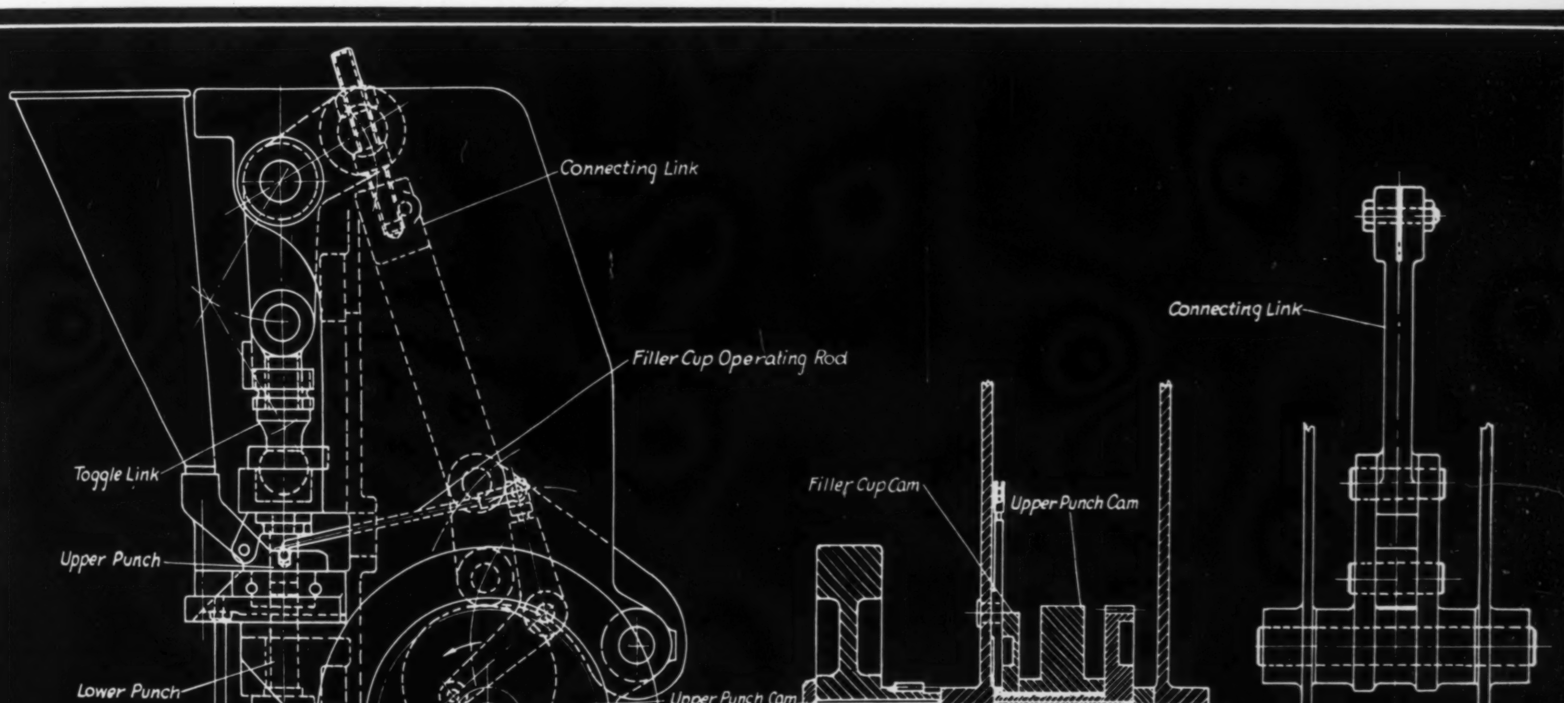

Connecting Link
Filler Cup Operating Rod
Toggle Link
Upper Punch
Lower Punch
Upper Punch Cam
Intermediate Gear and Lower Punch Cam
Lower Punch Bell Crank
Lower Punch Slide
Hydraulic Pump
Filler Cup Cam
Upper Punch Cam
Connecting Link

Fig. 2—Sectional view showing cam arrangement and hydraulic operating system for movement of punches. Upper punch is mechanically driven; lower is hydraulic

through use of a complete, self-contained hydraulic unit with all the necessary mechanisms, mounted inside a fabricated steel oil storage and supply tank as shown in *Fig.* 3. This unit was designed to fit partially inside the frame and rest on the base of the machine with the hydraulic ram in position directly under the lower punch carrier. The larger part of the unit extends out at the back of the machine and upon this rests the variable speed motor drive for operating both the machine and the hydraulic pump. Motor is double end, one end of which drives the hydraulic pump while the other drives the variable speed unit.

Hydraulic Piping Is Concealed

This assembly is compact and conserves floor space. Placing the hydraulic mechanism inside the oil supply tank has many advantages. All parts are immersed in oil, thus being fully and thoroughly lubricated. Any minor drip or leak that might develop in the pipe connections remains inside the tank. The unit is completely guarded against and protected from dirt or foreign matter which could cause trouble in the oil lines and valves. Also, a pleasing design is effected with the piping concealed and entirely out of the way.

Oil is delivered to a four-way valve which controls the direction of flow, as shown in the schematic hydraulic circuit in *Fig.* 4. The valve is operated by a cam which is an integral part of the mechanical portion of the machine. This cam is timed to operate the valve just before the upper punch in the machine reaches its down position.

When operated at this time, the valve diverts oil from the pump to a 6:1 differential booster. From the booster, the oil is directed to the bottom chamber of the hydraulic cylinder forcing the hydraulic ram upward. Pressure is held during a definite pause period to allow the material being compressed time to flow and set.

Further travel of the cam reverses the four-way valve, changing the direction of flow from the pump. Instead of going through the booster, the oil flows at direct pump pressure to the top chamber of the hydraulic cylinder, forcing the ram downward. At the same time, an automatic unloading valve is opened to release the oil in the lower chamber of the cylinder.

This complete cycle of hydraulic operation is repeated 10 to 50 times a minute in perfect timing with the mechanical functions of the press. Thus, by combining the advantages of mechanical and hydraulic operation, fast and accurate production is obtained.

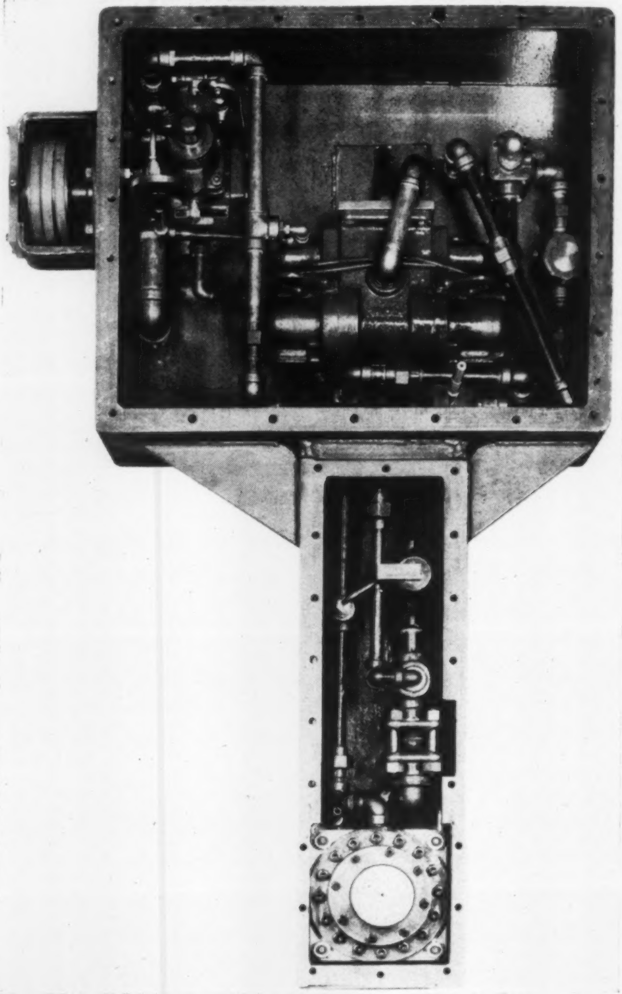


Fig. 3—Above—Plan view of hydraulic unit in base of machine. All piping and connections are within the reservoir, making for compact and neat design

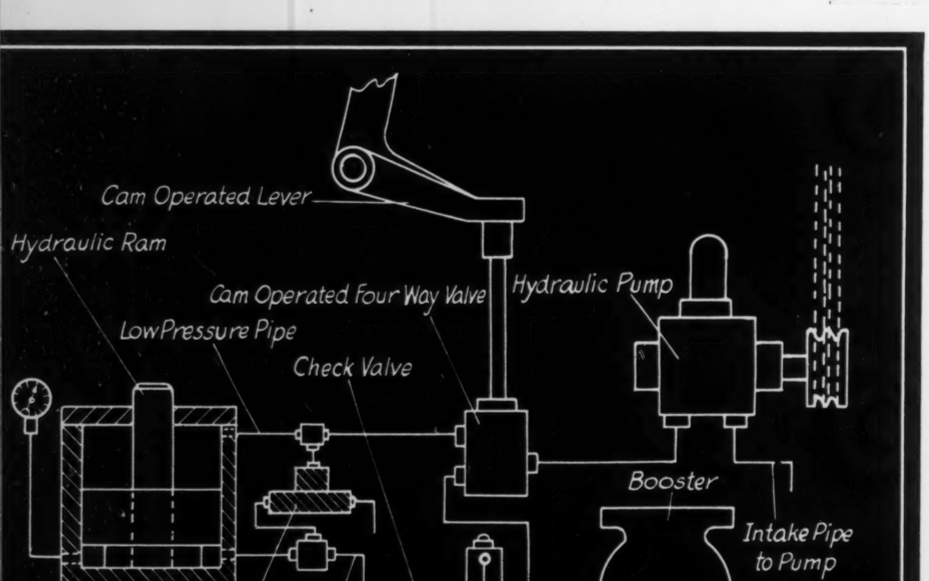


Fig. 4—Left—Schematic drawing of hydraulic system showing control of ram by cam-operated four-way valve and booster

Machine Fastenings in Design

Part I—Self-Locking Nuts

By Kenneth D. Moslander

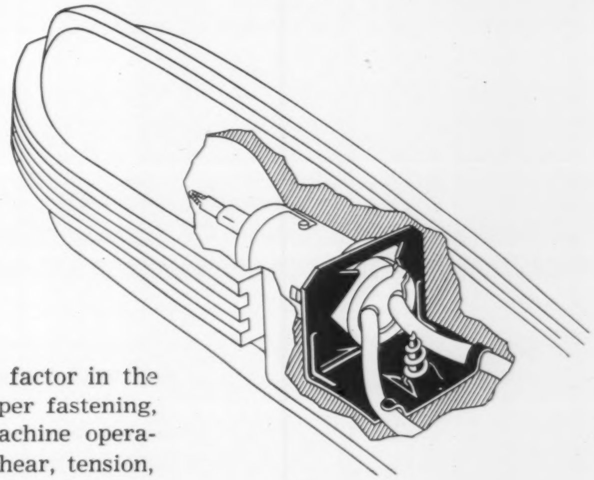


Fig. 1—Multipurpose nut used as bulb bracket in Buick parking light illustrates the basic nut form

MACHINE fastenings too often are considered a minor factor in the design of machines and equipment. Actually the proper fastening, properly applied, is essential to fully satisfactory machine operation. Adequate consideration given to unusual conditions of shear, tension, compression or vibration in the specification of a fastening will pay dividends in trouble-free operation of the finished machine or equipment.

The purpose of the series of articles of which this is the first is to provide the engineer with information about the several types of machine fastenings commercially available, as well as to point out the applicability and advantages of each. This information will be supplemented where possible by illustrative applications of the particular fastening described.

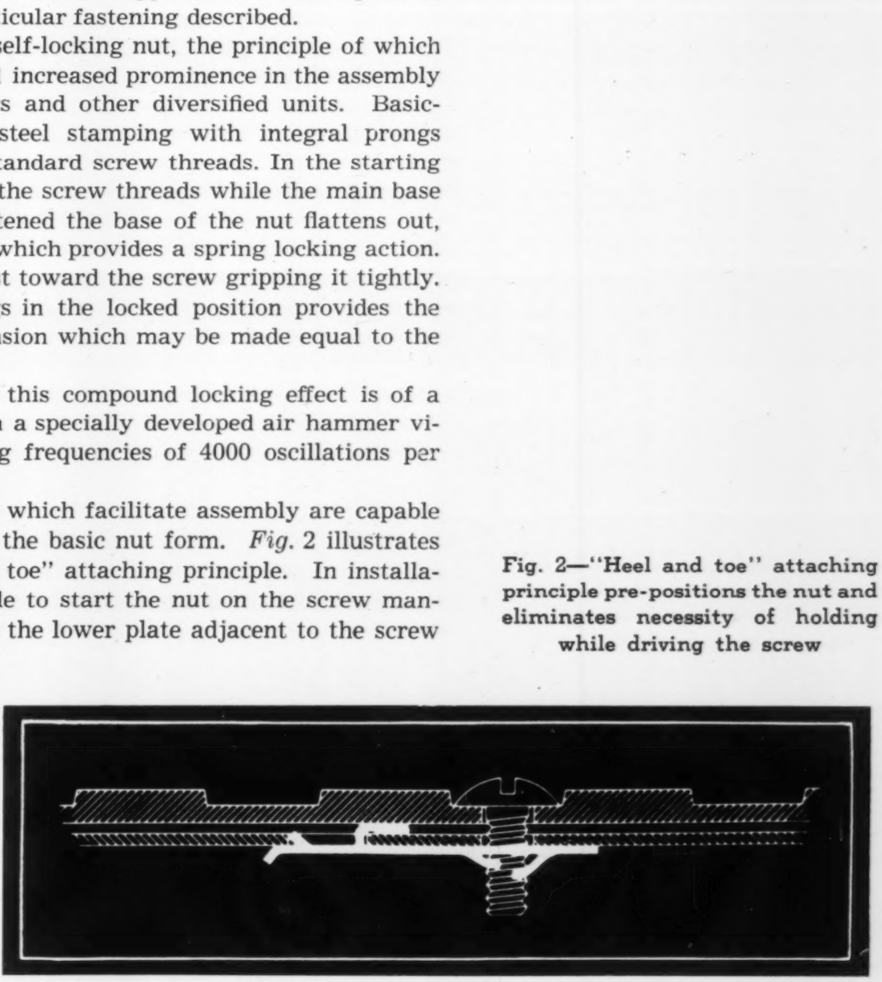
During recent years a one-piece self-locking nut, the principle of which is shown in *Figs.* 1 and 2, has attained increased prominence in the assembly of aircraft, automobiles, refrigerators and other diversified units. Basically this nut is an arched spring steel stamping with integral prongs formed to meet the helical pitch of standard screw threads. In the starting position the prongs are engaged with the screw threads while the main base is well arched. As the screw is tightened the base of the nut flattens out, exerting a tension force on the screw which provides a spring locking action. At the same time the prongs are thrust toward the screw gripping it tightly. The truss effect of the arched prongs in the locked position provides the nut with holding qualities against tension which may be made equal to the tensile strength of the screw.

Vibration resistance attained by this compound locking effect is of a high order, as amply demonstrated in a specially developed air hammer vibrating machine capable of producing frequencies of 4000 oscillations per minute at various amplitudes.

Many different auxiliary features which facilitate assembly are capable of being incorporated integrally with the basic nut form. *Fig.* 2 illustrates one of these, known as the "heel and toe" attaching principle. In installations where it is difficult or impossible to start the nut on the screw manually, a rectangular hole is formed in the lower plate adjacent to the screw clearance hole. The nut may then be snapped into this hole, thereby maintaining it in correct alignment with the screw and obviating the use of caged nuts.

Another type is the so called J-nut. This and the similar U-type are extensively used in fastening sheet metal panels, cowling, etc. where the screws are

Fig. 2—"Heel and toe" attaching principle pre-positions the nut and eliminates necessity of holding while driving the screw



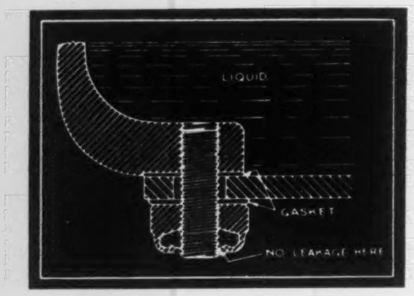


Fig. 3—Fluid - tight seal around threads is achieved by vibration resistant nut

inserted close to the edge of the backing-up plate. The J-nut is snapped over the edge of the backing-up plate thus holding the nut section in alignment with the clearance screws which are driven from the outside. Both of these pre-position the nut and obviate the necessity of holding while starting or driving home the screw. In addition, the J-type permits uninterrupted contact of one plate with its backing-up plate.

In many applications this nut is used not only as a fastening means but also for auxiliary purposes in an assembly. *Fig.* 1, the lamp assembly of the Buick parking light, admirably illustrates this versatility. Here the nut is used as a clamping bracket for the light socket and a spreader for the cables as well as a means of holding the entire assembly in position.

For die-cast or plastic molded parts these nuts are used over unthreaded studs formed integrally with the piece. Clamping action of the prongs bites into these studs holding the part against either tension or vibration. If separation of the parts may be desirable the studs are formed with a flat side so that a quarter turn of the nut will permit easy removal.

These fastenings are ordinarily made from spring steel strip containing from .7 to .8 per cent carbon although they are obtainable also, for special applications, of stainless steel, phosphor bronze or chrome molybdenum steel.

Nuts Have Built-in Locking Devices

Several types of nuts are commercially available with built-in auxiliary self-locking features which serve to hold the nut firmly to the bolt threads even under the most severe conditions of vibration or tensile deformation of the bolt. In one of these a vulcanized fiber collar is spun into the top of the nut. This collar, being unthreaded, resists the entrance of the screw, thus automatically taking up all thread play and bringing the load-carrying thread surfaces of the nut and bolt into tight pressure contact. Because of the resilient nature of the fiber the nut may be removed and replaced repeatedly without loss of the locking action.

Due to the complete seal of the fiber ring around the male thread, these nuts may serve the auxiliary purpose on fluid containers and the like of preventing leakage past the fastening thread as illustrated in *Fig.* 3.

Nuts of this type are available commercially in a wide variety of standard and special forms. One of these of particular interest is used for fastening sheet metal and light plate, the nut being of the clinch type with a knurled shank. In assembly the shank is pressed into a drilled or punched hole and the lip upset against the back of the plate. The nut is thus held firmly in position, the knurled section resisting rotation when the bolt is driven home.

Made of steel, brass, aluminum, stainless steel, etc., and incorporating U.S.S., S.A.E., Whitworth or other thread systems, these nuts have enjoyed extensive applications in aircraft assembly.

Another nut capable of locking itself firmly to a standard bolt or stud is illustrated in *Fig.* 4. These nuts have an arcuate-shaped metallic locking ring spun into the face of the nut adjacent to the work. When the nut is screwed down tightly this ring is crushed flat, its inner edge gripping the bolt threads. This deformation is not elastic. Grip on the bolt is maintained even if, as a result of bolt stretch, the nut no longer is flush with the work surface.

Special Rings Used for Corrosive Service

While the nuts may be used repeatedly without impairing their locking action, it is recommended that in applications requiring a correct fit in bearing and similar adjustments the nut be reversed until the final adjustment has been made. The nut may then be applied with the locking ring next to the bearing housing and tightened down, thus locking the nut to the bolt or stud with a vibration resistant grip. Assembled in this manner, the correctness of the preliminary adjustments will be maintained.

For corrosion resistant service locking rings of duronze, everdur and monel are available. Since the nuts are all metal they are unaffected by heat or moisture met with in nominally severe service.

A type of self-locking nut that is receiving wide acceptance is one which, upon tightening, closes around the male thread with a vibration-resistant grip. The inner bearing surface of this nut is recessed so that the entire bearing load is carried on an outer annular bearing surface. The opposite end of the nut has six narrow longitudinal slots extending through the center of the flats of the hexagon.

When tightened down the reaction of the work against the bearing ring creates a couple with the thread thrust, causing the slotted upper sections of the nut to close in on the bolt or stud. This elastic deformation of the nut imposes a positive tension in

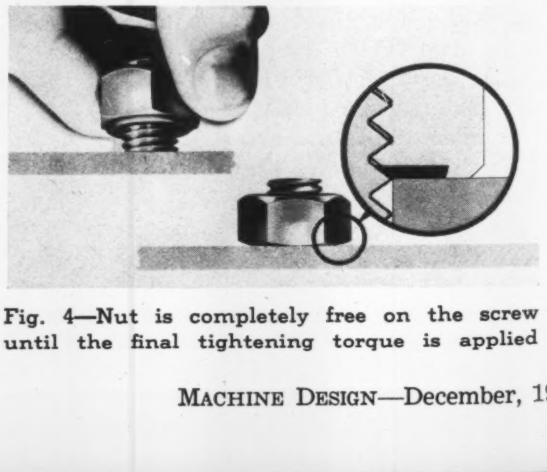


Fig. 4—Nut is completely free on the screw until the final tightening torque is applied

the bolt and also results in a more complete distribution of load on the engaged threads. *Fig.* 5 illustrates an application of these nuts in fastening the connecting rod bearing caps of a Pontiac engine.

Differing somewhat from the above described nut, another type is available which also grips the end of the bolt by means of built-in spring action. This nut resembles, to some extent, a castellated nut with the exception that the trailing edges of the slotted sections are bent inward slightly after threading. These inwardly depressed edges offer only nominal resistance to tightening but grip the bolt firmly in opposition to any tendency toward backing-off of the nut.

Designed to achieve locking action between the male and female threads without the use of springs or other auxiliary gripping devices, the special thread form illustrated in *Fig.* 6 locks in the final quarter turn of the nut or cap screw. The root of the male thread is formed in two concentric frustroconical steps, each tapering at an angle of six degrees. The female thread is tapered at a similar angle to engage by a wedge fit the outer step when the reactive pressure of the work on the nut or screw head forces these two surfaces together. In this position positive locking of the threads is attained not only under conditions of vibration and elastic elongation of the screw but also under rotational tendencies of the work in relation to both the bolt and nut.

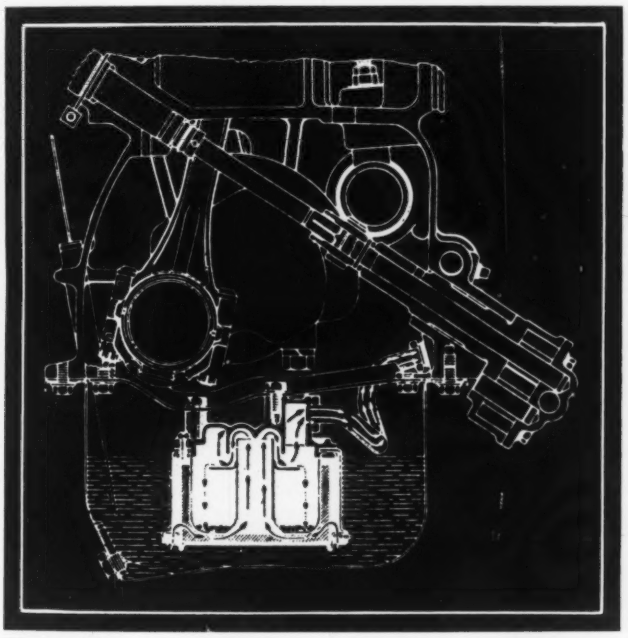


Fig. 5—Elastic deformation of the nut positively fastens connecting rod bearing cap

Because of the greater root diameter of this thread than that of a conventional V-thread screw of the same nominal size, increased strength in both tension and shear is obtainable. Absence of the pronounced notch effect of the V-thread screw contributes to greater resistance to shock loading.

As an example of savings through application of this type of fastening, breakage of guard rail bolts in rapid transit systems were reduced one-third by their use. Other important applications are in aircraft, automobiles, agricultural machinery, pneumatic tools, etc.

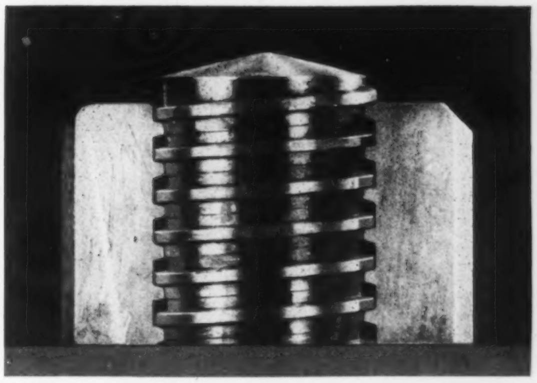


Fig. 6—Special thread form, shown in locked position, resists backing off by reason of wedge action between the male and female threads

Intimacy with which the threads are engaged in the locked position has led to a further rather interesting use in electrical service. In applications where these fastenings have an auxiliary function as an electrical terminal or as a part of an electric circuit, laboratory research has determined that they possess 80 per cent less electrical resistance across the threads than conventional screws.

Additional fastenings systems to be discussed in subsequent articles include machine screws, bolts, nuts and lock washers as well as recessed and socket head screws; other special machine fastenings also will be covered.

MACHINE DESIGN gratefully acknowledges the contributions of the following companies to this article: Tinnerman Products Inc., *Figs.* 1 and 2; Elastic Stop Nut Corp., *Fig.* 3; Laminated Shim Co., *Fig.* 4; National Machine Products Co., *Fig.* 5; Dardelet Threadlock Corp., *Fig.* 6.

New Motor Standards

CHANGES in motor dimension standards adopted by the National Electrical Manufacturer's Association should result in new compactness in the design of machines incorporating electric motors. As a result of these changes the 1½-horsepower squirrel cage motor as made by one manufacturer now weighs 25 per cent less, and occupies 27 per cent less space than previous models of the same speed rating.

These smaller motors are possible because of two major engineering advances; silicon steels have been greatly improved until now less motor iron is necessary to produce the same horsepower and better insulations have been developed which have a higher dielectric strength and, at the same time, occupy less space.

It will be seen that resulting from the cumulative effect of many technological advances through a period of twelve years of unchanged motor standards, the new standards have brought about spectacular improvements in electric motor size, weight and appearance.

What Surface Deviations Are

By O. R. Schurig
General Electric Co.

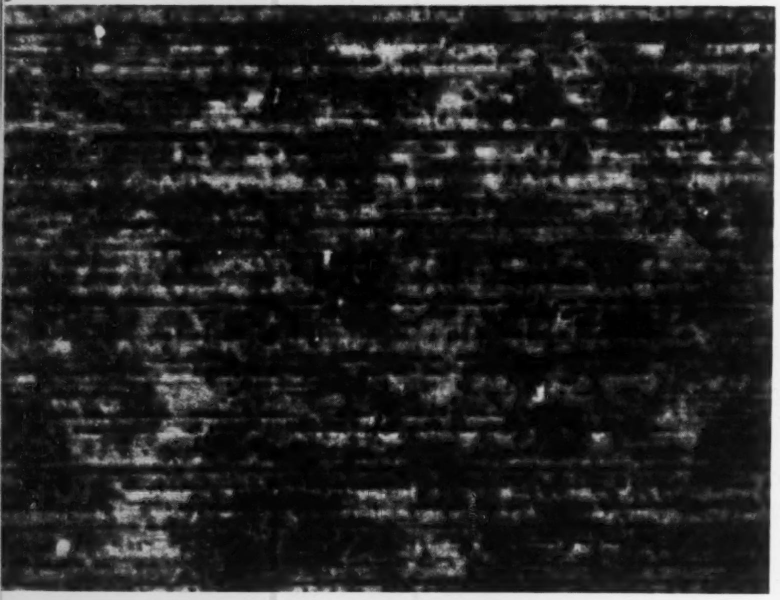
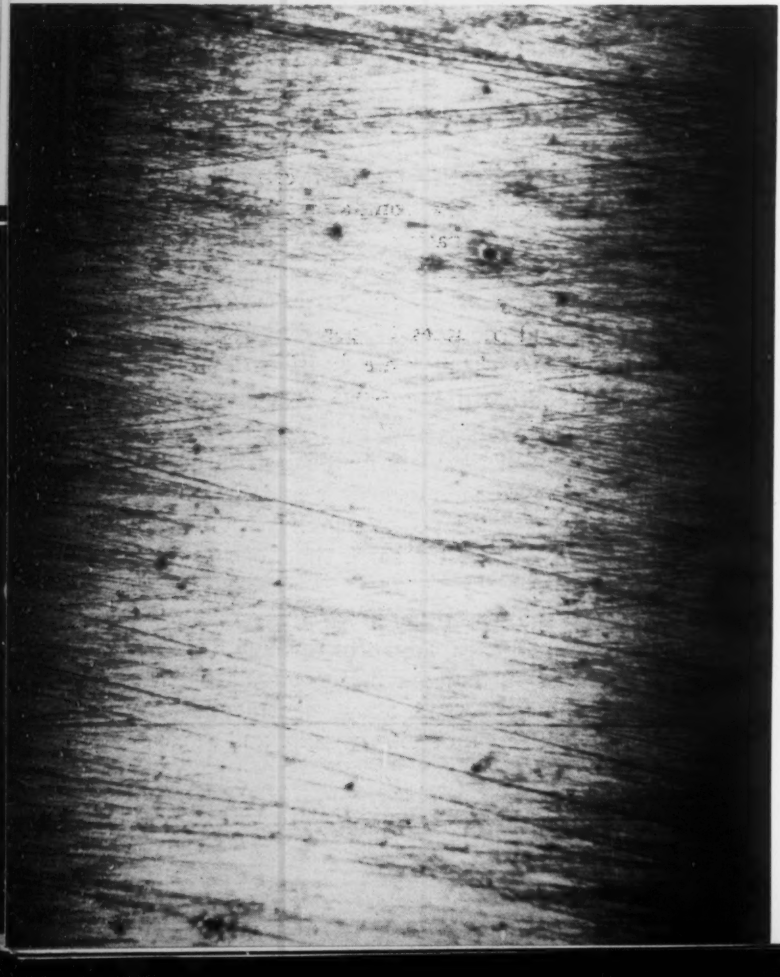


Fig. 1—Photomicrograph of cast iron runner plate surface showing parallel concentric marks. This waviness must be reduced to prevent scoring

Fig. 2—Below—The substantially concentric finish marks on this oil pump bore suggest a distinction must be made between projections above and depressions below surface



ALTHOUGH an American standard has been proposed for describing surface roughness, no national standard has yet been set up to include the description and designation of other surface deviations such as waviness or surface flaws. Yet it is probable that these additional surface qualities will also require description in any final standard. By illustrating some of the types of surfaces in which engineers are interested, by pointing out some of their characteristics and by reviewing the requirements they must meet, it is hoped that progress will be made toward determining what geometrical qualities are important for surfaces in different applications. The standard already proposed provides, it will be recalled, for expressing surface roughness numerically as the root-mean-square average of the ordinates of a surface profile with respect to its center line.

Thrust bearings such as used on vertical shaft hydroelectric generators consist of a flat smooth runner plate of chilled cast iron which runs on babbitted bearing shoes immersed in a bath of oil. *Fig.* 1 shows a photomicrograph of the runner plate surface (magnification 35X). Finish is lapped with parallel concentric finish marks and then polished, with visual inspection for surface roughness and flaws. Reduction of waviness to prevent scoring is of utmost importance.

Reduction of Waviness Important

Tests were made comparing starting friction for runner plates finished by different processes which gave both random and parallel concentric finish marks. It was concluded from the tests that for these surfaces, reduction of waviness and parallel finish marks in the direction of motion are important. Possibly a rough surface with marks parallel to the direction of motion may be as useful as a smoother one with random marks.

Another rubbing surface is in *Fig.* 2, the bore of a small oil pump used in a refrigerating machine. Small pump blades slide on the surface of the bore.

Presented at the special summer conference on friction and surface finish, Massachusetts Institute of Technology.

re Significant?

Finish is honed and polished with substantially concentric finish marks, parallel to direction of sliding. A production test for waviness, roughness and surface projections is given each piece, with visual inspection in addition. The chief requirement for this surface is freedom from chattering because of surface irregularities encountered in the direction of motion, i. e., peripherally. Freedom from projections above the surface met in direction of motion is particularly important, whether caused by roughness, waviness, or nicks of any kind.

These observations indicate that, in surface finish designations of roughness and of waviness, a distinction between projections above and depressions below the prevailing surface contour may be needed. The question arises therefore as to whether the description of a surface should not take into account the direction of irregularities above or below the surface, as a significant factor in surface quality, and one previously unaccounted for.

High Production Methods Used

Attention is called to the fact that *Fig.* 2 depicts an example of a very smooth surface manufactured by high-speed production methods, used in large quantities for more than five years. Each piece is carefully tested to determine its fitness for the exacting job it has to perform.

The thrust bearing plate shown in *Fig.* 4 at a magnification of 50X must operate without objectionable noise and wear as a load-bearing surface at 1750 revolutions per minute. Its casehardened steel surface is ground and honed. Each sample is visually inspected. Experience has shown that with accurate control of manufacturing operations no tests are needed for waviness and roughness, though reduction of both is important. Roughness measurement on occasional samples was two to three micro-inches root-mean-square. A grinding finish was previously used, but operation was noisy and gave indications of wear. The surface shows a random pattern of finish marks which is not objectionable considering the smoothness of the surface.

Since the chief function of all bearing surfaces is to carry a load without scoring or forms of wear or noise, the question arises whether the available contact area per unit nominal area is a measure of surface quality. R. J. Walker has suggested a designation including a figure expressing in per cent the amount of bearing surface in relation to the whole

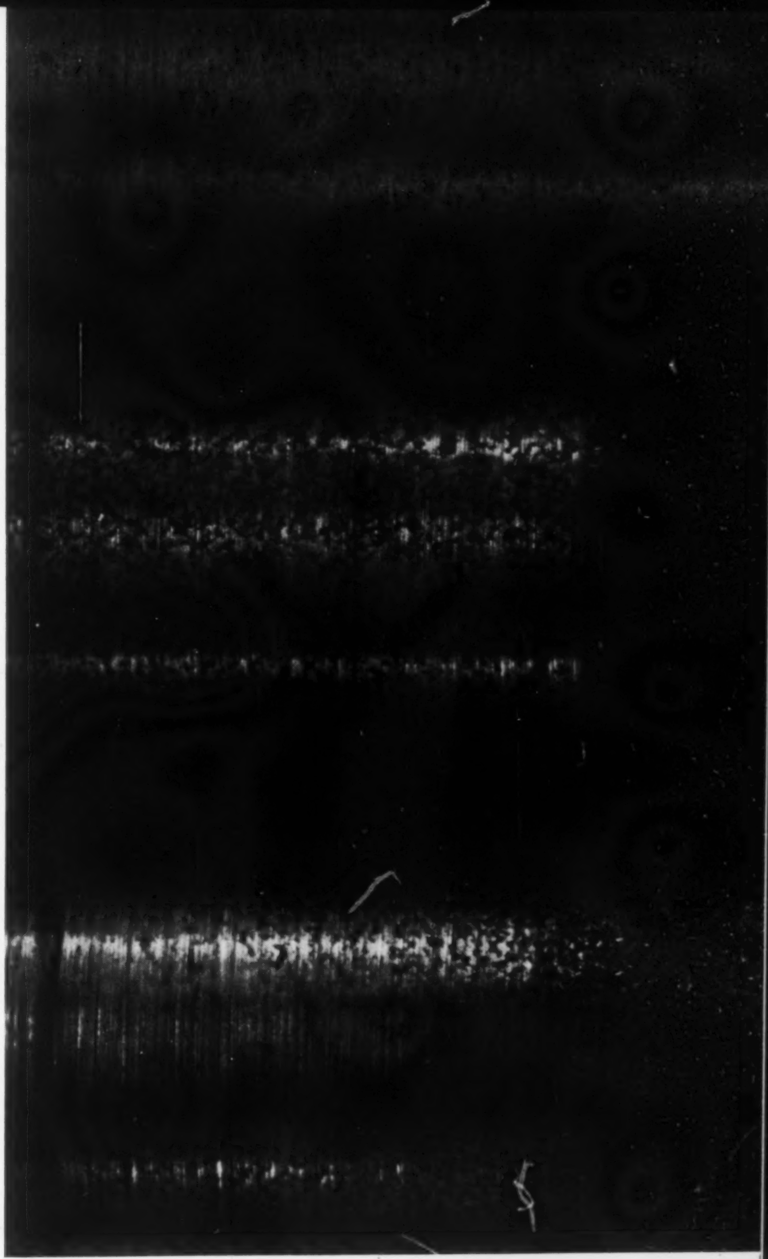
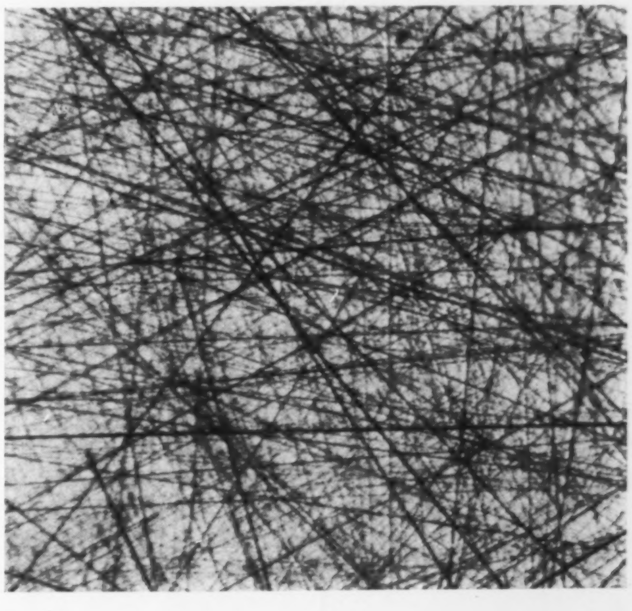
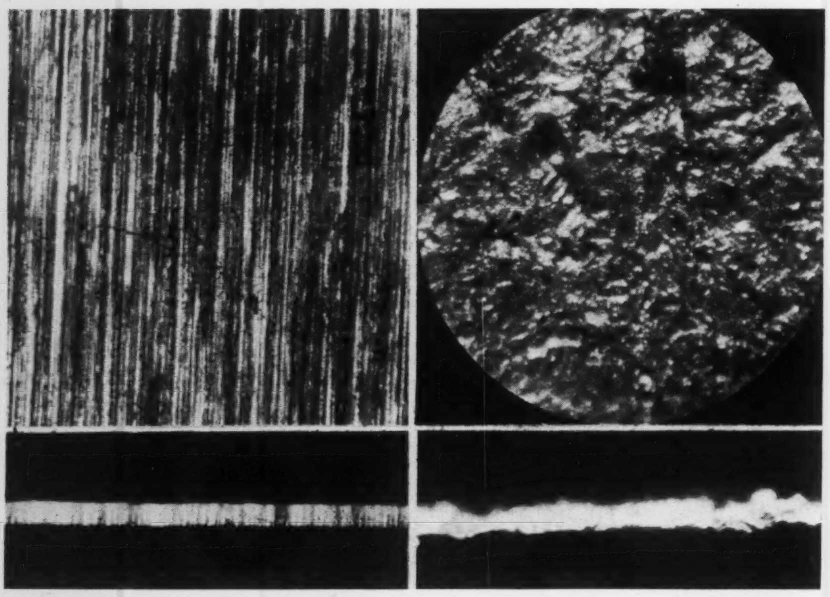


Fig. 3—Surfaces of three drill rod journals, before and after finishing. Top journal was sand blasted, middle one grit blasted, bottom journal ground

Fig. 4—Below—Thrust bearing plate operates without objectionable noise and wear but is only visually inspected. Finish marks show a random pattern





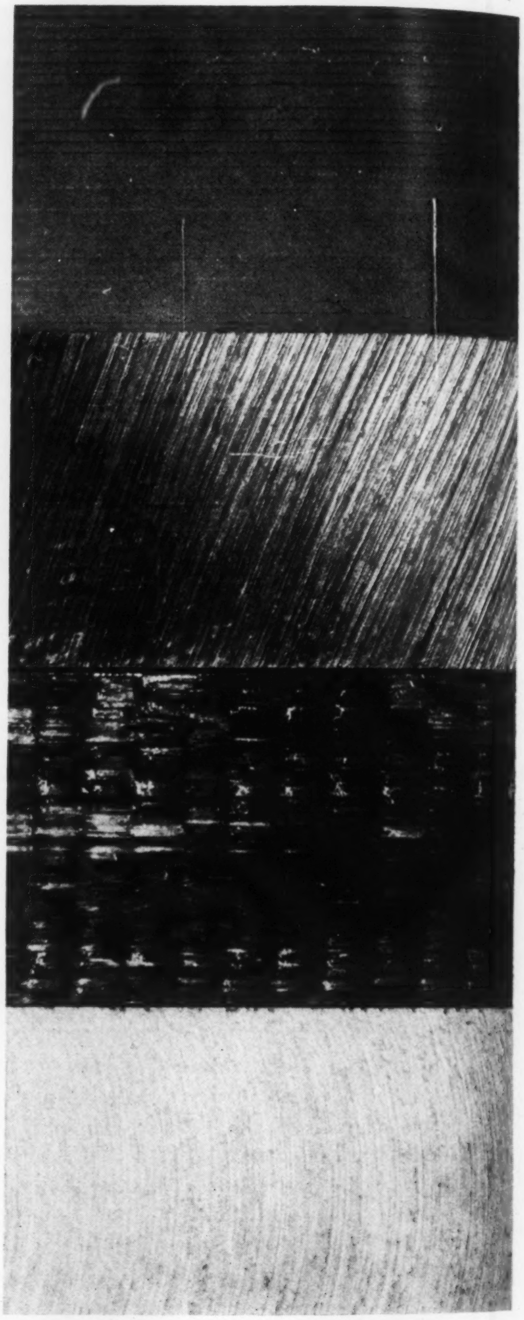


Fig. 5—Plan view photomicrographs and surface profiles of ground and sand-blasted surfaces. Short wave lengths characterize ground surface. Fig. 6—Right—Four sample blocks with same overall root-mean-square roughness are nevertheless far from identical in appearance and surface

surface, though no evidence is given to point out quantitatively its significance in the usefulness of a surface.

In connection with the discussion of bearing surfaces an interesting preliminary series of tests was run, comparing a ground and polished drill rod journal one-fourth of an inch in diameter with similar journals having surfaces finished by sand blasting and by grit blasting. The rods were operated against ground, cold-rolled steel bushings by the use of an Almen film strength testing machine to determine the load-carrying capacity up to the breakdown point of the oil film. *Fig.* 3 shows the surface condition of the three journals, illustrating both the original surfaces and the surfaces after operation. The results of the tests were as follows:

TABLE I

Surface Finish	Rms Roughness Micro-Inches on Original Surface	Max. Load Lbs. per Sq. In.	
Ground and polished...	18	8,500*	seizure took place
Sand blasted	60	24,000	no seizure
Grit blasted	60	28,900	no seizure

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*Average of two tests; seizure occurred in both tests, at 8440 and 8570 pounds per square inch.

Fig. 5 shows plan view photomicrographs and surface profiles by the light-slit method for (a) ground surface (original) of a plane surface which measured 16 micro-inches root-mean-square roughness; (b) sand-blasted surface (original), of one-fourth inch shaft, 60 micro-inches. In the two lower illustrations, the boundary line along the bottom of the lighted area shows the surface profile. The ground surface in these illustrations shows the rather jagged irregularities of relatively short wave length; while the sand-blasted surface is characterized by a profile of larger wave length with relatively wide cavities and pockets.

While exhaustive tests on the relative merits of the two surfaces in question, for bearings, have not yet been made, the following tentative conclusion is indicated: The sand-blasted surface and the grit-blasted surface, though rougher, appear to have an advantage over the smoother ground surface having materially different profile shape, in respect to load-carrying ability in a bearing, but would not be expected to show any reduction of losses under normal running conditions. Harry Shaw has suggested that a smooth surface is not always better than a rougher one and based this conclusion on load-carrying tests of metal-sprayed steel shafts having a porous surface compared with hardened steel shafts. Furthermore, John Wulff has pointed out that it is possible for surfaces of the same material, finished by different methods, but all measuring two micro-inches root-mean-square roughness, to behave differently in respect to strength, friction, corrosion and erosion. It is not known whether this is caused by the shape of the surface alone or by the characteristics of the metal below the surface.

To emphasize the difficulty of specifying a number of surface requirements numerically by use of the root-mean-square height of the surface profile, a part like the rim of an exhaust valve disk of a refrigerating machine may be cited. This disk must not leak gas when it is held against the valve plate, and a high standard of flatness and freedom from scratches deep enough to allow gas leaks is required. Furthermore, a minor projection would apparently be far more serious than a depression of similar proportions.

Use of Form Factor Suggested

Under these circumstances use of a form factor in addition to a height value has been suggested. One such recommended form factor is the ratio of the average height to the maximum height above the base line, as indicated in *Fig.* 8. For non-moving parts which must fit closely, as in joints, it is obvious that 100 per cent contact of the surfaces would be ideal. Hence the per cent contact area might be a criterion for the quality of a contact surface.

The uniformity and wave length of surface irregularities are often suggested as another basis for describing surface quality. In this connection, *Fig.* 6 shows four sample blocks having the same overall root-mean-square roughness of approximately 130. From top to bottom, these blocks were, respectively, shaper machined, ground, milled and end milled. The four surfaces are far from identical in appearance and surface quality.

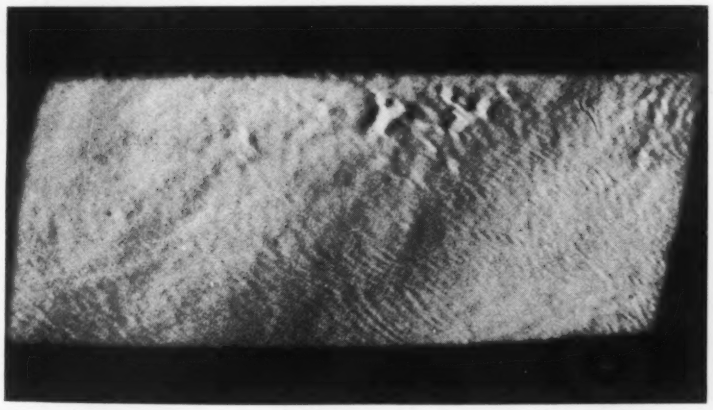


Fig. 7—Image of a polished steel surface, showing deviations from flatness in the light and dark areas which visual inspection would not reveal

Obviously, the root-mean-square designation alone will not distinguish between the four surfaces. It has been suggested that the root-mean-square designation be qualified by reference to the process used in finishing. But this sort of qualification would not be necessary if it were really known how to describe a surface; i. e., if it were really known what surface deviations were of interest.

Various studies have shown that the fatigue limit of a member is materially affected by the finishing process it has received, the fatigue strength diminishing with increasing depth of finish marks, or of individual scratches. It is also well established that the curvature at the base of the scratch is a factor in the fatigue strength. Should not, therefore, a designation of surface quality enable one to distinguish between scratches and projections and provide for a more complete description?

Among the many other functions and properties of a surface which are affected by its shape are the following: Heat transfer by fluid flow (forced convection); heat conduction by direct contact; flow resistance; evaporation of liquids; condensation of vapors; luster; appearance; corrosion; erosion. These properties likewise must be considered in determining what qualities of a surface are important and how they should be described.

In connection with surface waviness, *Fig.* 7 is the image of a polished steel surface, approximately 2 inches by 2 inches, showing deviations from flatness in the light and dark areas and waves in the image. While this image does not give numerical indications of the magnitude of the deviations, it clearly shows, for the entire surface, in the case of flat polished surfaces, the presence of the waviness deviations not observable by ordinary visual inspection.

Problem Demands Combined Effort

Fig. 8 summarizes graphically a number of geometrical characteristics which have been suggested or considered in connection with the description of a surface. Average height above base line of profile curve is indicated by h; maximum height above base line, is H; form factor is h/H; root-mean-square is average of ordinates of profile curve measured with respect to center line; wave length is L; a and b are illustrations of surface profiles with irregularities respectively above and below the prevailing contour.

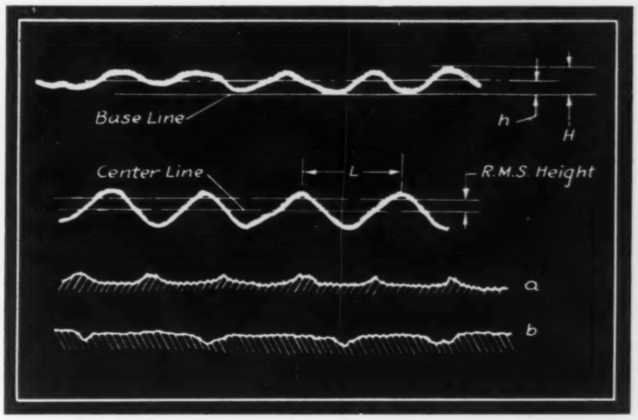


Fig. 8—Summary of a number of geometrical characteristics suggested or considered in connection with the description of a surface. No one is entirely satisfactory

From this summary it is evident that the solution of the problem of establishing an adequate basis for specifying significant surface characteristics will require the combined effort of a wide group of persons and organizations concerned with all phases of the problem.

Friction Drive Transmits Full Power

By K. H. Booty
Central Scientific Co.

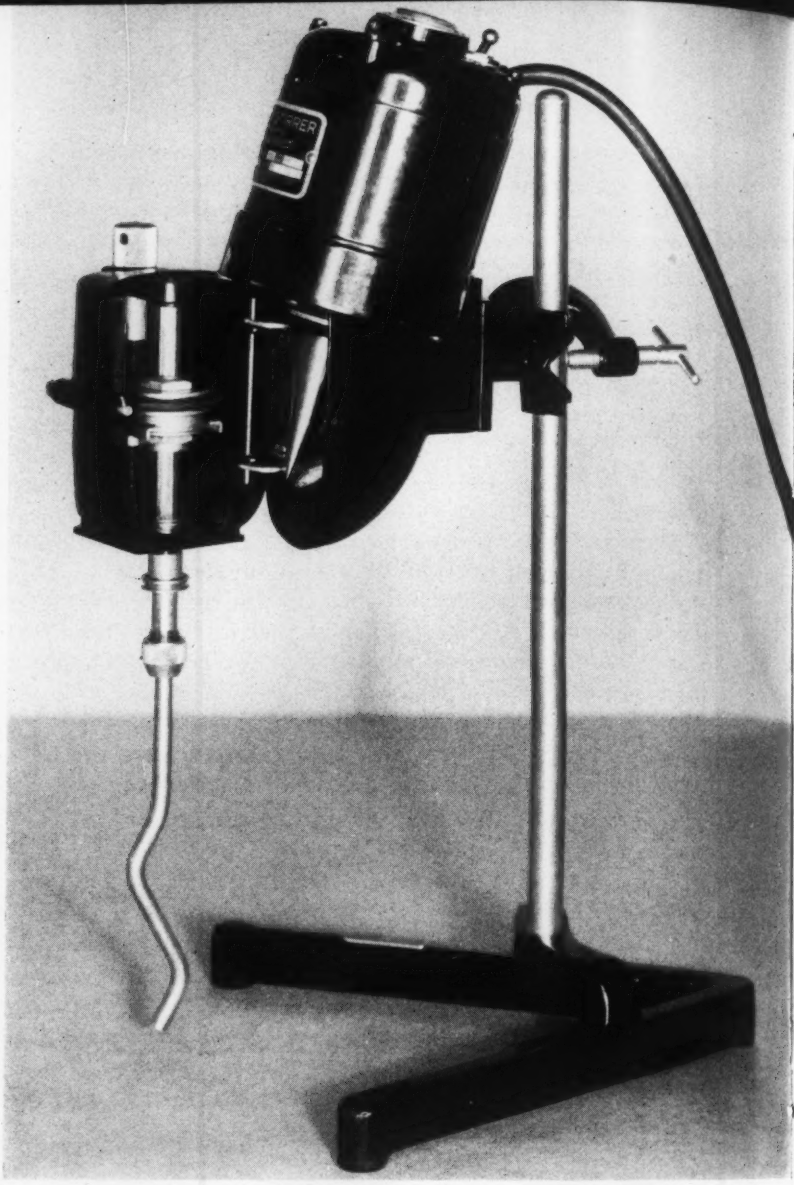


Fig. 1—Friction drive on laboratory unit delivers variable speeds with constant power

PREVIOUS disadvantages of friction type cone and disk variable speed drives have been eliminated in the small stirrer unit, *Fig.* 1. Shearing forces on the friction material have been reduced and provisions have been included for varying the pressure on the disk element proportional to the load. These refinements combine for good efficiency and constant power output throughout the speed range and capacity of the stirrer, as shown in the curves of *Fig.* 2.

Power is transmitted from a cone on the motor shaft to a rubber friction disk keyed to the driven shaft to allow axial movement for speed adjustment, *Fig.* 3. The motor is tilted to such an angle that the element of the cone in contact with the friction disk is vertical and paralled with the driven shaft. Thus, regardless of speed adjustment the position of the driven shaft remains the same. With the plane of the rubber disk perpendicular to the element of the cone in contact with it, the frictional force on the edge of the cone is tangential and the shearing forces on the rubber, inherent in those designs using a disk for driving, are eliminated. Life of the rubber disk and the efficiency of transmission is thereby increased.

Housing Has Concealed Hinge

Totally enclosed, the driving mechanism is housed in a two-part die-cast housing which protects the mechanism from vapors and also prevents particles of rubber worn from the disk from dropping into a solution being stirred. The rear half of the housing supports the motor and bracket; the front half contains the speed-changing mechanism composed of the driven shaft, the driven disk assembly, the shifter fork and shifter screw. This fork engages the driven disk assembly through a ring which with its bearing is locked in place between the lower flange of the hub and the lower flange of the friction ring. A coaxial nut at the top holds together the driven disk assembly, including the rubber disk, the shifter ring and the hub.

Extension of the shifter fork through the front housing forms a speed indicator. To prevent turning of the shifter screw from vibrational forces a compression spring inside the knob holds a short, steep-tapered section interposed at the junction of the screw and its small diameter shank against a corresponding tapered fit in the housing. Thus the speed ratio remains constant at any level to which it is manually adjusted. The sleeve over the screw shown in the drawing provides an upper limit of travel for the rubber disk.

The front housing is attached to the rear housing by a concealed hinge. A latch consisting of a plunger with a cross pin which engages a bayonet slot is in the rear housing. Inside the plunger cavity is a compression spring, the outer end of which is fixed in position by the plunger, with the free end mounted in a seat provided for it in the die casting. This drives the housing inward and the rubber disk is applied against the cone with pressure. The vertical geometry of the hinge and latch system is such that this pressure is even from top to bottom through the vertical movement of the disk. The horizontal geometry of the hinge, the cone, and the driven disk, and its relationship to the direction of rotation, has the effect of producing additional applied pressure, which is self-compensatory for the amount of load on the stirrer. In other words, a heavy drag on the shaft tends to rotate the housing inwardly about its axis, increasing the friction between the cone and the rubber disk.

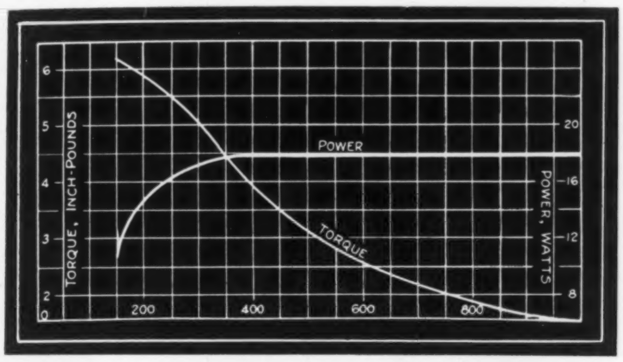


Fig. 2—Power and torque curves plotted against revolutions per minute indicate high efficiency of drive without slipping

Excess Capacity Is Provided

Mounted in an oversize frame to reduce operating temperatures, a 1/70 horsepower split-phase induction motor drives the unit. This type motor is utilized because of its constant speed characteristics with varying loads. This is important in stirrers of this kind because of viscosity changes that sometimes take place as a liquid is being stirred. The motor is equipped with a ball bearing at its lower end and a wick-oiled sleeve bearing at the top.

Power input in the range of speeds shown in *Fig.* 2 is 17.7 watts as compared with the theoretical 10.65. This demonstrates both high efficiency and excess capacity of the speed-changing mechanism. Power delivered between 375 and 1000 revolutions per minute is constant as shown by the curves. This indicates that power is delivered at high reductions throughout the speed range without slipping. Below 375 the motor, being overloaded, began to lose speed and at 150 the starter switch cut in terminating the experiment to determine drive efficiency.

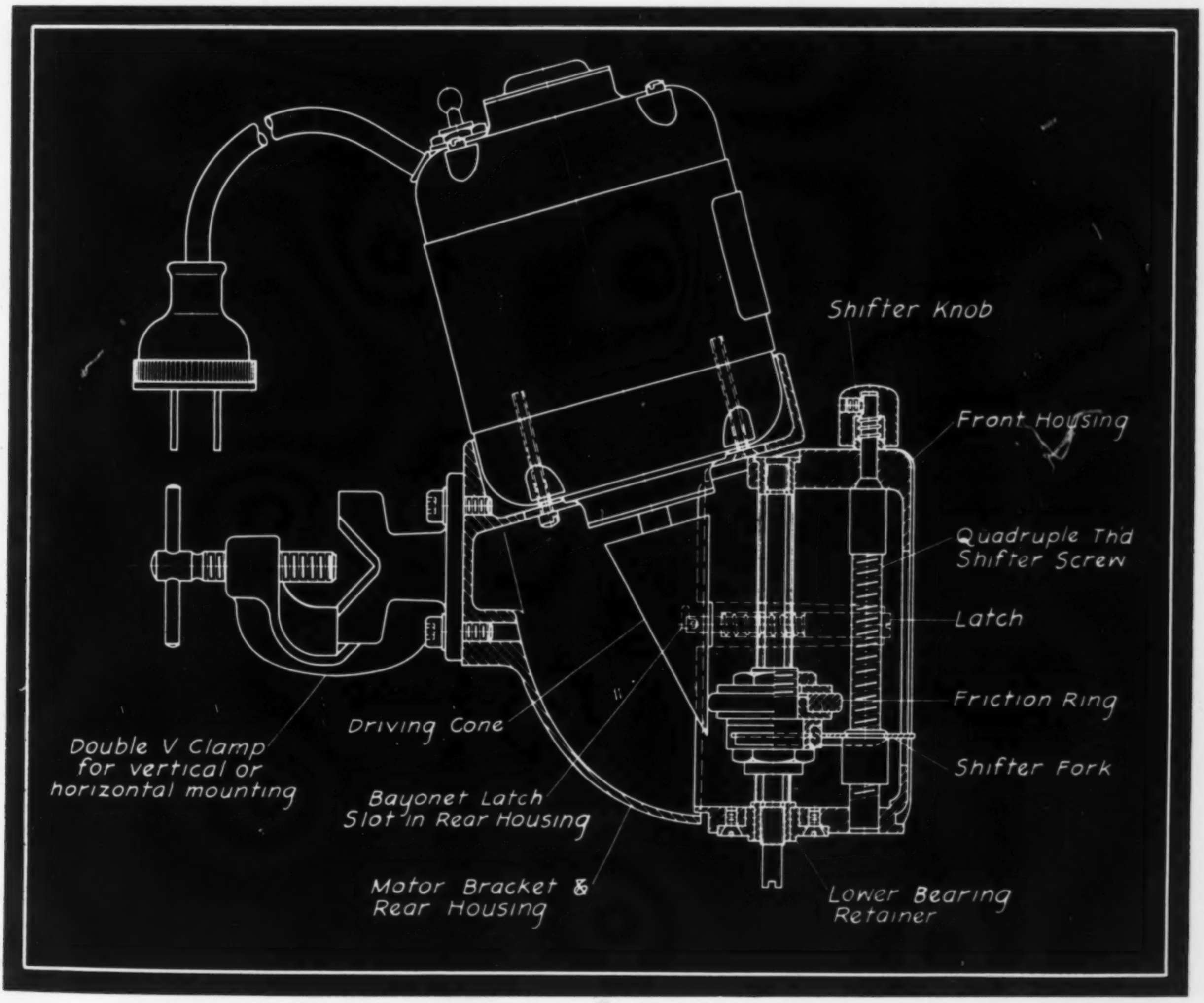

Shifter Knob
Front Housing
Quadruple Thd Shifter Screw
Latch
Friction Ring
Shifter Fork
Lower Bearing Retainer
Double V Clamp for vertical or horizontal mounting
Driving Cone
Bayonet Latch Slot in Rear Housing
Motor Bracket & Rear Housing

Fig. 3—Below—Arrangement of cone drive. Shifter fork friction ring and driving cone are shown together with latch design serving dual purpose of closing unit and maintaining friction on drive

Hard-Facing Permits Combination of Toughness, Hardness

By George Z. Griswold

HARD-FACING offers the advantage of combining in one piece the excellent abrasion, impact and corrosion-resisting properties of specially developed alloys with the toughness and shock resistance of an inexpensive base metal, usually steel. In locations subjected to the effects of heat, use is permitted of an alloy with the ability to retain its original hardness. At the same time a readily machinable base metal may be utilized for easy fabrication and assembly with other parts by high speed production processes. If metal such as heat-treated tool steel were used instead of hard-facing, only a compromise between hardness and toughness could be reached.

In general, hard-facing alloys may be classified in two groups according to their method of application. First group includes ferrous base surfacing materials ranging from low cost alloys with small nonferrous content to those with nonferrous content from 20 to 50 per cent. With cobalt as the base, nonferrous cobalt-chromium-tungsten alloys with negligible iron content are also in this group, which is welded on by the oxyacetylene or electric arc method. Applications of this group in design will be discussed in this article, including an intermediate group comprising tungsten carbide particles held in place on wearing surfaces by the welding application. A subsequent article will cover another group which includes small individual castings or inserts of sintered tungsten carbide, bonded in place with steel.

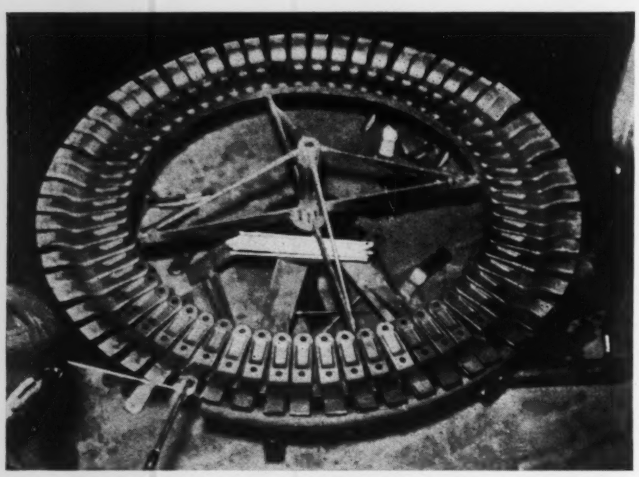


Fig. 1—Trenching machine teeth are readily weldable steel, hard-faced with tungsten carbide tube rod

Most important advantage from specification of hard-facing is increased service life of parts. Hard-faced parts will outwear unfaced ones from two to 25 times, depending on the type of alloy and the service to which it is subjected. Parts replacements and shutdowns are then reduced, lessening operating cost. Since it is possible to keep the total cost including surfacing from exceeding the cost of single-metal design, overall cost is also brought down.

Many Alloys Developed

Only a few hard-facing materials approach the combination of desirable characteristics such as inherent hardness; ability to be applied easily; melting point slightly lower than steel; coefficient of expansion close to that of the base metal; and resistance to abrasion, corrosion and high temperature oxidation. Hence a great number of alloys have been developed to meet the hundreds of different conditions encountered.

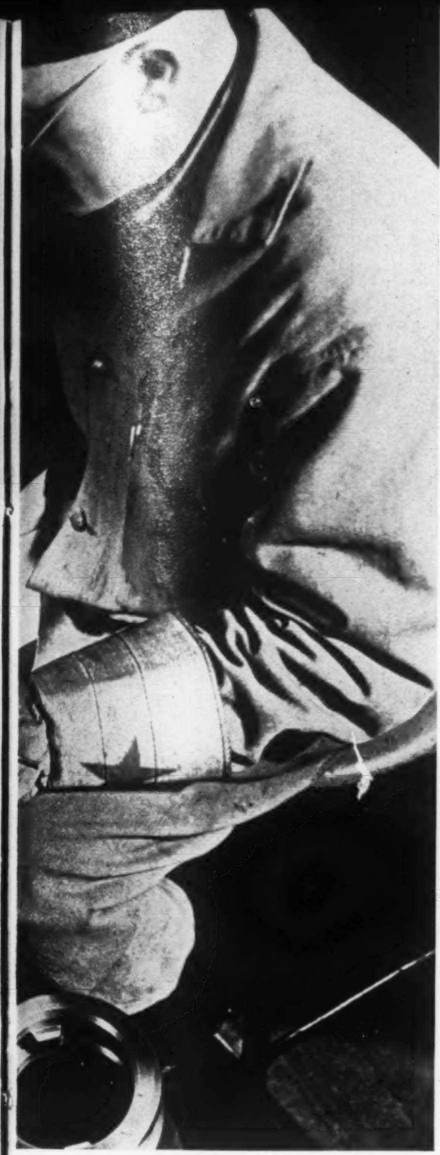


Fig. 2—Left—Steam valve seat rings are one of best-known applications of hard-facing and must withstand high pressure and high temperature

TABLE I shows the characteristics of a few of these alloys, but is intended only as a guide since several qualifications must be made. Values given are average ones obtained under laboratory conditions, and will vary with the mass of parent metal, size of bead applied, rate of cooling, electric current if arc welding is employed, etc. In many cases no heat treatment is necessary or desirable, but when heat treated the hardness of a part is usually increased slightly. Work hardening will result in more appreciable gains in hardness.

No Particular Mystery Involved

Because hard-facing involves dealing with dissimilar metals under an intense heat, care must be used in its application. There is no particular mystery about it provided certain general precautions are observed during the design of machine parts to be hard-faced.

These influences include considerations of the size and contour of the part itself; selection of a suitable base metal and of the best hard-facing material; provision for adequate support for the hard metal if it is to be subjected to shock or high pressure; correct preparation of the base metal; adequate strength in the members of intricately shaped parts which may have to be preheated. These factors are important even when parts are standard ones subjected to hard usage, like the trenching machine teeth in *Fig.* 1. When parts are designed to more precise specifications, however, particular attention should be given to these considerations.

Size of the part to be hard-faced influences several other factors, including the base metal to be specified. In the case of large parts, ductility of both the base metal and the alloy is important. Otherwise welding stresses will be set up in the finished part and the alloy itself may crack during cooling after the welding heat. For example, large pump shaft sleeves are best hard-faced with an alloy of good wear and corrosion resistance, which can be applied without cracks. With a cobalt-chromium-tungsten alloy the desired smooth finish is easily obtained and cracks in the deposited metal can be eliminated by proper relation of wall thickness to the diameter of the sleeve. Smaller sleeves, however, can be hard-faced with the hardest grade of this particular alloy, without danger of cracks if the base metal is ductile and the wall thickness is not too great.

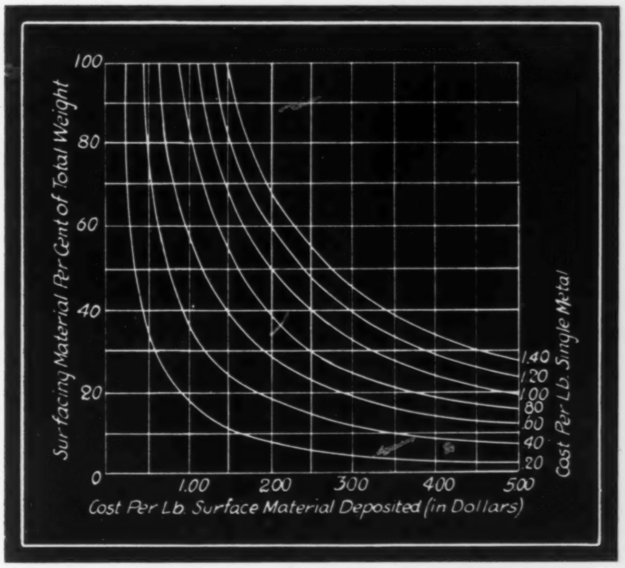


Fig. 3—Right—Per cent of total weight of surfacing material which will give a cost not exceeding single-metal cost, may be determined from this graph

Among the latest and most unusual applications of hard-facing involving a large part at high heat is a plug cock valve operating under extremely corrosive conditions with temperatures as high as 1000 Fahr. With a brinell hardness of approximately 545, a hard-facing alloy is welded to the mating surfaces of the plugs and body seat. Because the coating is applied to sections of varying thickness over a large surface, problems are introduced of contraction and expansion of irregularly shaped sections. In some cases the hard-facing has to be applied over an intermediate layer of other highly ductile metal in order to provide a satisfactory base metal to take care of expansion and contraction strains set up during welding.

When these valves are intended for high temperature service they are subjected to a special lapping operation in which the plug is fitted into the body at temperatures approximating those of actual service. This process provides for an accurate fit of the

TABLE I

Characteristics of Typical Hard-Facing Materials

Type of Deposit	Application	Brinell Hardness	Remarks
Medium carbon steel	Resists wear, deformation	255-269	Dense, tough surface
High carbon steel	Resists shock, abrasion	285-318	Tough, fairly hard
Cobalt, chromium, tungsten	Resists extreme abrasion, slight to heavy shock	402-512	Corrosion resistant, red-hardness
Medium carbon alloy steel	Resists rolling or sliding wear	375-495	Fair resistance to corrosion
High speed steel	Cutting edges, metallic friction	601-653	Fair resistance to corrosion
Manganese steel	Resists shock, abrasion	388-444	Tough, nonmagnetic
High carbon alloy steel	Resists impact, severe abrasion	429-555	Good corrosion resistance
Stainless steel	Resists impact, abrasion	331-470	Extreme corrosion resistance
Iron, chromium, manganese, silicon, carbon	Resists abrasion	514-545	Nonmagnetic

plug and also permits securing uniform distribution of pressure over a certain surface. Accumulation of pressure on localized areas with a consequent rise in the unit pressure is thus prevented.

Use of hard-facing materials on these valves, moreover, permits use of lubricants particularly adapted to high temperatures, or otherwise resistant to the fluids encountered by virtue of their plastic sealing qualities without special regard for their ability to overcome frictional resistance in the valve. This fact widens the field for use of plastic lubricants which otherwise would be limited on account of service conditions encountered. Consequently the field for the valves has been extended to include temperatures as high as 1200 degrees Fahr. and pressures to 5000 pounds per square inch.

Although cracking because of contraction beneath the hard-facing is not such a pitfall with small parts, other requirements may influence the choice of base metal. On parts such as automotive valves and valve seat inserts, or steam valve seat rings as shown in *Fig.* 2, the base metal is exposed to corrosion, high temperature or both, while the hard-faced deposit is subjected in addition to erosion. Stainless steel, alloy steels, nickel alloys and other corrosion-resistant alloys can be used as base metals on most small parts which must withstand these severe conditions.

Recommend Plain Carbon Base

The most generally recommended base metal for hard-facing is a plain carbon or a low alloy steel containing about .4 per cent carbon, such as S.A.E. 1040 or 3140. Corrosion-resistant base metals already have been mentioned, but copper, copper alloys, aluminum, magnesium and other metals of low melting point cannot be hard-faced economically except in rare instances. Cast iron is not as easily hard-faced as steel. High speed steel is seldom hard-faced because cracking usually occurs near the bond line during cooling. Manganese steel is hard-faced only with the electric arc and is usually too costly for extensive use as a base metal, since plain carbon or low alloy steels give firm enough support.

Furthermore, when stainless steel, plain carbon or low alloy steels containing more than .6 per cent carbon are used as base metals, they should be annealed before and after hard-facing to give increased ductility. Cast iron is not heat treated.

Influence of the part shape on hard-facing problems, as has been said, centers around warpage, shrinkage, or cracks. Cylindrical surfaces, large circular shapes, large flat areas or long thin parts to be hard-faced longitudinally usually require attention during welding and cooling to minimize warpage and to prevent the differential contraction of the dissimilar metal from causing cracks in the deposit.

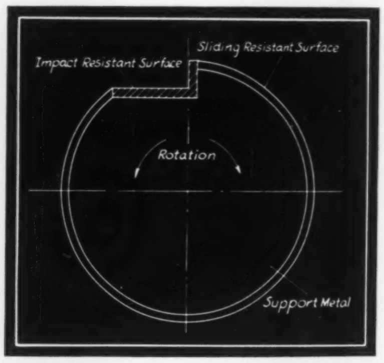


Fig. 4—Two kinds of hard-facing are applied to this cam, to resist impact and sliding, respectively

A case in point is the cam in *Fig.* 4, on which two

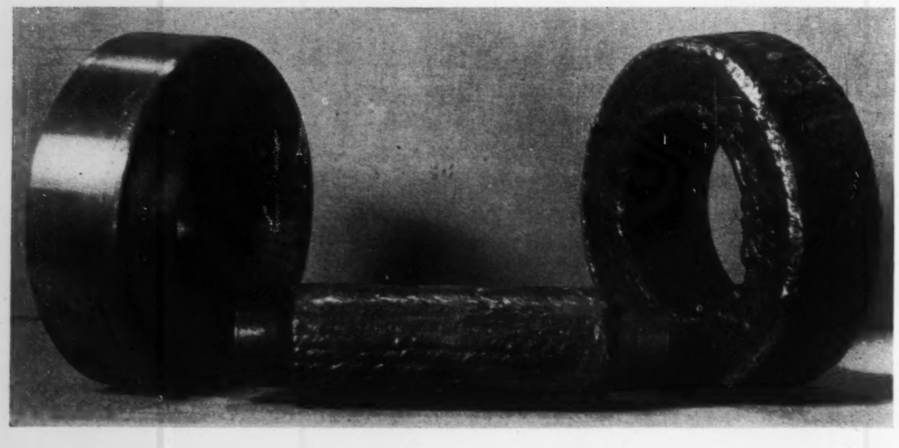


Fig. 5 — Hard-faced rollers for bending and forming steel angles

types of hard-facing are welded. At the point of impact, an impact-resistant bead is placed, and at the sliding point, a bead of sliding-resistant alloy is welded.

Large circular parts of course contract when hard-faced, so that the designer should allow sufficient oversize stock to permit finishing the parts to the specified dimensions. Cylindrical surfaces, such as the pump shaft sleeves previously mentioned, should be welded in a special predetermined order of events which will compensate for warpage tendencies. Contraction is greater at the center than at the ends Hard-faced rollers used for bending and forming steel angles are shown in *Fig.* 5.

Long thin blades are usually given a back bend during welding, contraction of the deposit pulling the blade up straight. But since these procedures are common knowledge in welding departments, consultation is wise to assure that the deposit can be handled satisfactorily with equipment on hand.

Once the base metal has been chosen, location of the hard-facing alloy and the contour of the supporting surface are most important. While it is simple to determine the surfaces to be protected, the width of the deposit and contour of the supporting metal offer opportunities for choice in design.

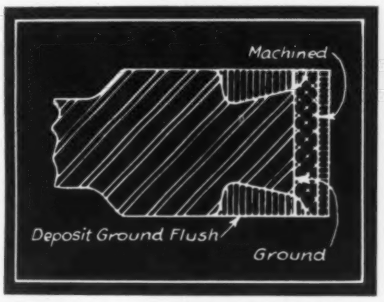


Fig. 6—Left—Finishing schedules of hard-faced parts are important. Fig. 7—Right—Scraperblade in machine for mixing bread dough is hard - faced along edge indicated

In the design of the support several precautions should be taken. All sharp corners should be rounded off to promote uniformity of heat absorption during welding and avoid melting or burning of corners. Sharp internal corners also should be avoided, as it is difficult to obtain a sound bond between the alloy and the base metal unless such a recess is made concave with a radius of at least ⅛-inch.

While a production operation, the finishing of a hard-faced part is important to the designer, particularly when considerable machining is done after the alloy is deposited. *Fig.* 6 shows a typical finishing schedule, and reveals a considerable change in the contour of the part.

Back-Bending Prevents Warping

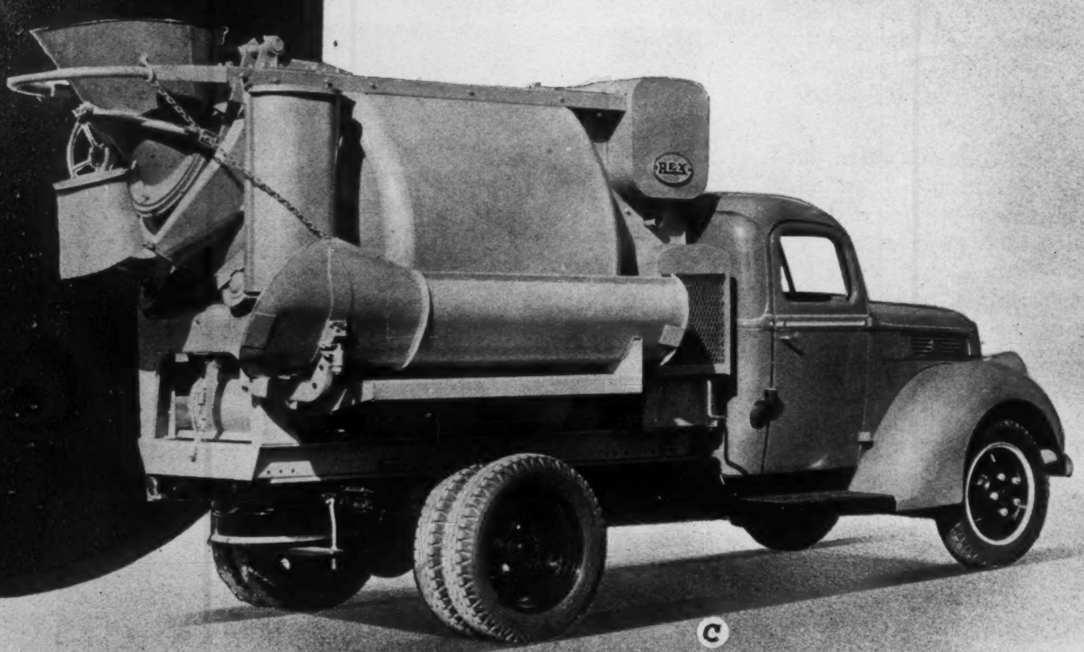
Scraper blades for dough mixers like that in *Fig.* 7 are hard-faced by an interesting procedure. The steel strips are cut by a groove 1/16-inch deep and ½-inch wide. During hard-facing, warping is avoided by back-bending the blade. When the deposit is completed, the edge of the strip is machined off at a 30-degree angle up to the underside of the deposit and is then ground to the desired shape.

Although hard-facing alloys are usually expensive they are welded on base metal which may be cheaper than the medium-priced metal used in a single-metal part. Hard-facing need not be used, moreover, except where it is in direct contact with the loading. Hence the total cost of the equipment including surfacing need not exceed that of single-metal construction. As a rule at least 20 per cent of the total weight of a part may be hard-facing material without exceeding single-metal cost. *Fig.* 3 graphically shows various percentages by weight of hard-facing which may be used, plotted against the cost in cents per pound of single metal. It should be noted that too much or too deep surfacing may be undesirable and unprofitable.

The primary reason for the constantly growing number of applications of hard-facing alloys is as always the need for longer wearing machine parts. Never before was the need so pressing as in the present emergency, when designers face tremendously greater responsibilities.

Co-operation of the following companies in the assembly of information and illustrations for this article is acknowledged: Haynes Stellite Co. (*Figs.* 1, 2, 6 and 7); Lincoln Electric Co. (*Figs.* 3, 4, and 5); Merco Nordstrom Valve Co.; and Wall-Colmonoy Corp.

TWO gas-driven turbines for operation on otherwise wasted by-product gas will be used for catalytic processes in oil refineries, one in California and the other in Texas. Built by General Electric, the machines will be similar to usual steam turbines except that they will operate on high temperature waste gases. They are rated 3250 and 400 horsepower.



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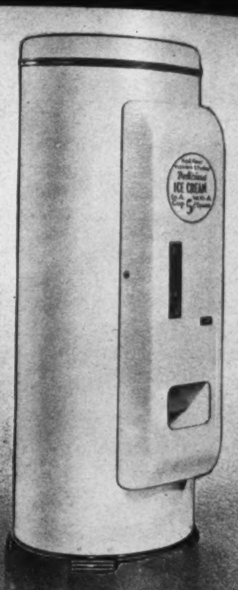

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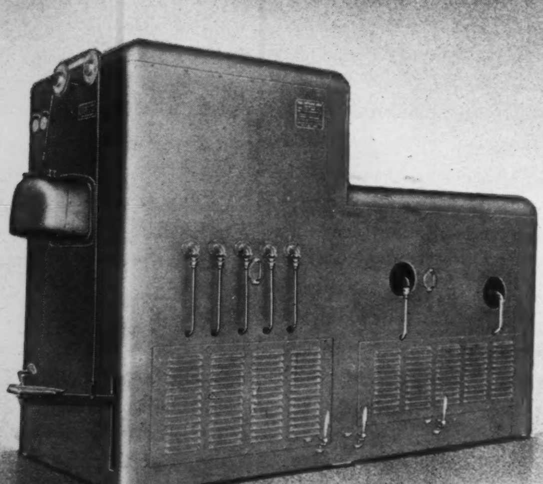

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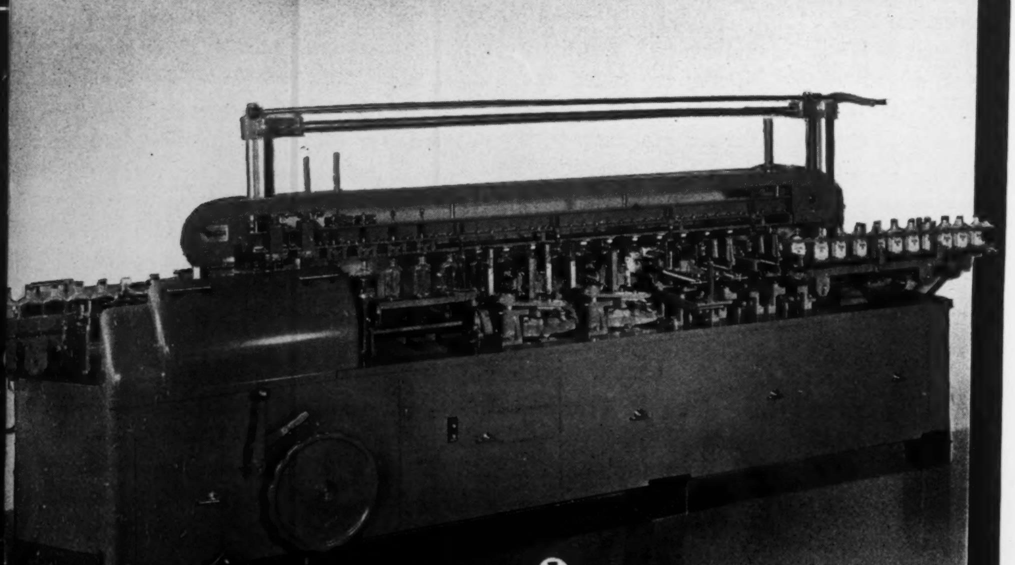


A

Design

IN NEW M

(For new machine li

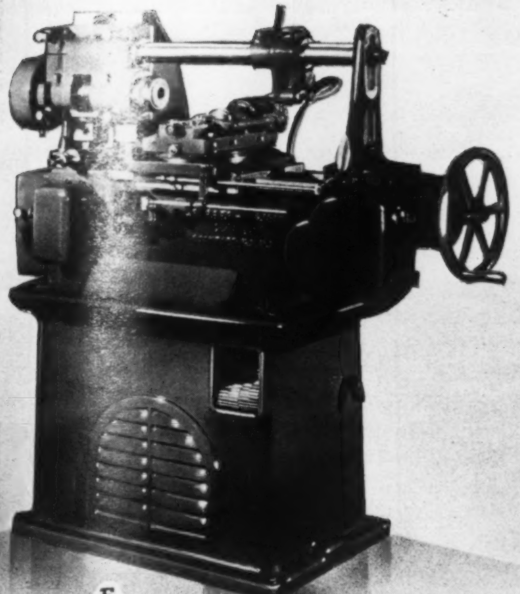
THIS MONTH'S COVER. Power of universal motor in KitchenAid mixer is controlled in ten speeds by electric governor. Drive is direct through steel or plastic gears. For complete mixing, mixer travels around bowl in one direction and turns on axis in opposite direction. Attachment hub on front of transmission case obviates need for power adapter and provides for driving different attachments. Frame is zinc alloy die casting in white enamel

Handling two bottles at once, the Pneumatic Scale labeler (A) has an ingenious intake permitting feeding of bottles in groups or singly, with varying spacing. A slow moving index spider correctly spaces bottles for pickup by the direct line intake carrier, beneath housing at left. A mechanical "spotter" regulates labeling of round bottles

Furnace gases are neutralized by a special compound in the Lithco atmosphere furnace (B). Because the neutralizing element is in excess, any oxygen released is absorbed, and ferrous metals and alloys can be heated without decarburization, carburization or scaling. Control is fully automatic. Frame of furnace is tubular while shell is in one piece, welded. Finish is heat-resistant gray enamel

Rex Moto-Mixer (C) has a manganese alloy steel drum so designed that there are no inaccessible places where cement can build up, and hence the mixing action scours all parts of the drum and results in self-cleaning. A single opening is used for charging and discharging. The rear charging hopper serves as a receiving hopper and a stationary throw-back blade during mixing, affording visibility of batch. Drive is by chain, with twin clutch transmission

Circular rotating magazine of the Revco ice cream cup vendor (D) is actuated by coin-operated gearmotor which simultaneously ejects cup, opens delivery door, indexes magazine and dispenses a wood spoon. Zero temperature compartment has glass wool insulation and molded rubber



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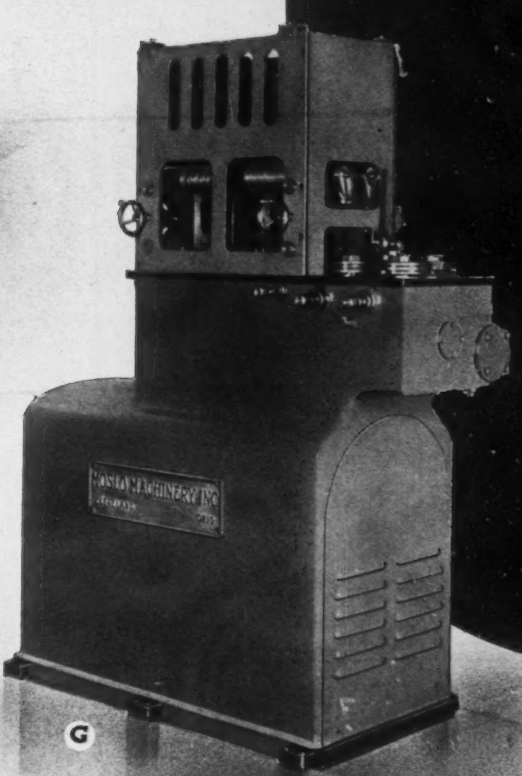

G

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MACHINES

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heat breaker parts. Finish is enamel over bonderized steel

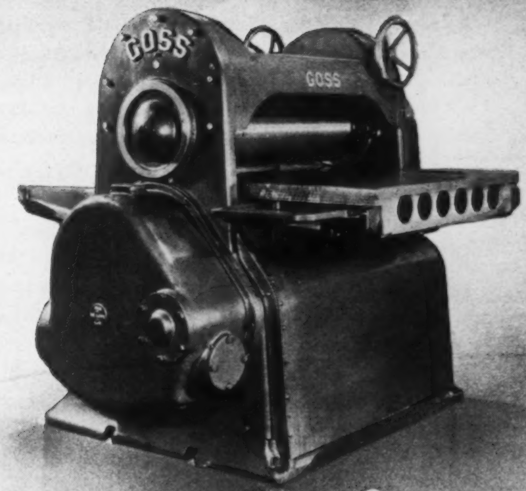
Motor of Barber-Colman hobbing machine (E) is mounted on floor of sub-base and drives by V-belt at rear. Centrifugal pump delivers coolant from reservoir cast integral with sub-base. Feed drive is through spur gear transmission to worm and worm gear on feed screw. Base and sub-base are heavy castings, upright column is integral with bed

Automatic time control regulates Toastswell toaster (F) which has silent clock and thermostat mechanism. Chromium plated housing is smoothly styled and accentuated by black plastic base and trimmings. Toast can be released for inspection at any time. Bottom plate is removable

Accessibility to parts is increased in Moslo welding rod hopper feeding machine (G) by placing feeder rolls in a vertical plane while support shafts are in a horizontal plane. Wire is fed uninterruptedly to extrusion press teamed with the machine, and feeding speed of press is matched by variable speed transmission. Drive is totally enclosed, running on tapered roller bearings. Gears are alloy steel

Proper illumination of the platen surface in the Goss mat roller (H) is provided by a concealed Lumiline light built in the top of the arch. Impression adjustment is conveniently located. Flexible drive automatically adjusts itself to combined characteristics of the printing form, mat and molding blanket. Machine was redesigned to incorporate double worm gears which give smoother, quieter operation

Cross slides of Polymatic screw machine (I) derive movement from individual plate cams and are hardened and ground steel on cast iron ways. Small lubricating pump is contained in the base for flood lubrication of all moving parts. A common camshaft controls feed movements, and speeds are varied by pickoff gears. Friction clutch starts spindle and feed movements



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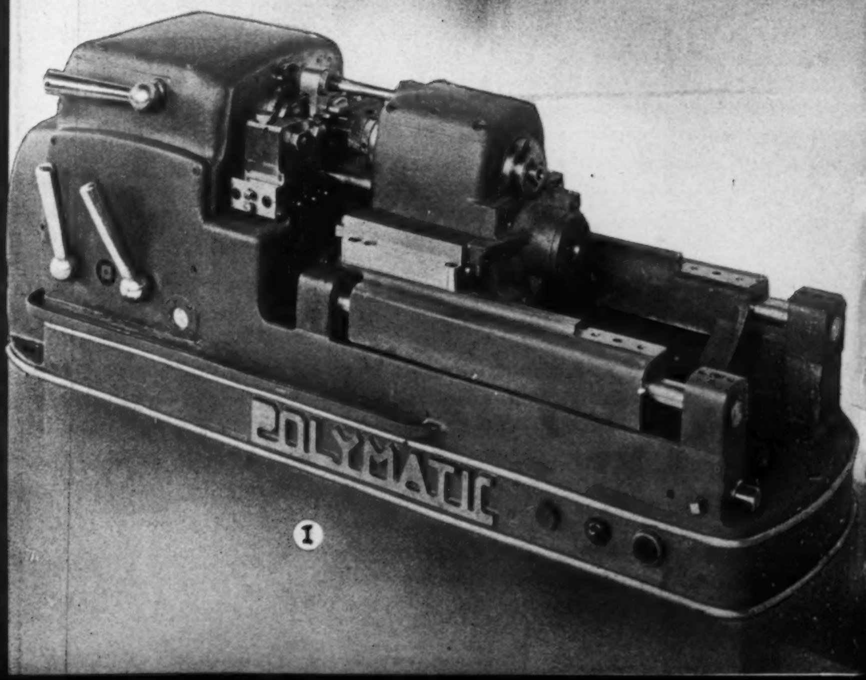


I

MACHINE *Editorial* DESIGN

Armament Program May Be Held Up—But Not By Designers!

THE fate of Coventry and other cities proves again, if that were necessary, that the conflict raging in Europe is nothing if not a machine war. It seems inevitable that the victory finally must go to the nation or nations that can put into the field the best, and the biggest quantity, of military and naval armaments. Once again machine designers and the equipment they develop play an overwhelmingly vital role in the future course of nations and the world.

That this country is rapidly assuming its stride in connection with defense measures is clearly evident from two basic industries tied in closely with the armament program. Steel is being produced, according to index figures, at 97 per cent of the nation's capacity, and machine tools being turned out at a rate approaching double that of a year ago. Figures for military and naval equipment such as airplanes, tanks and warships are not so readily available but every indication points to the fact that these show even more amazing increases.

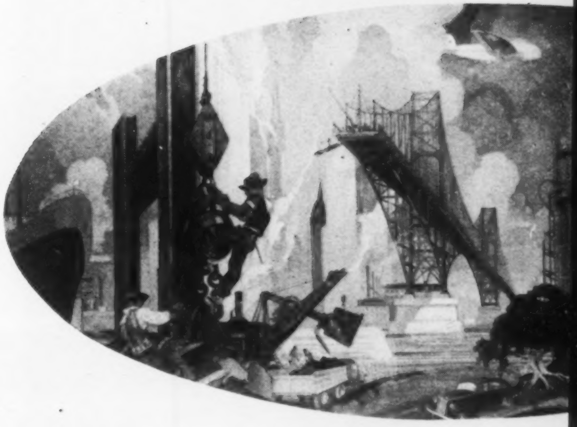
With this constantly improving tempo of defense production it comes as a shock to find that one of the country's important airplane plants can be entirely held up by a strike of workers. Freedom of action is one thing in peace time but another in a national emergency. The sooner the proper agencies are set up to arbitrate differences between the employers and employed of plants engaged in or connected with the armament program, the better it may prove to be. There is no such thing as "walking out" on the part of those called up for service under the draft and it is hard to see the difference between them and the men producing for their needs. Perhaps the answer would be to permit the latter to work under a production draft system rather than a military draft system until peace can be definitely assured!

Machine Design is gratified that its readers constitute a professional group of engineers who, singly and collectively, are carrying out their responsibilities loyally and well in these days of stress. May they be deserving of the nation's increasing backing and esteem.

In Machine Design

FOLLOWING the successful reception of R. E. Orton's series of articles "Photoelastic Analysis in Commercial Practice" (reprints of which, incidentally, are now available) Machine Design is pleased to announce that another series of articles by the same author will make its appearance during the early months of 1941. This series will cover commercial aspects of application of the elastic theory.

Plans have been completed also for publication of articles on other subjects, in series, that are vital in design. It is believed that the coming year will establish a record high for presentation of effective contributions to the design field.



Metal Show Stresses Effect of Engineering on Defense

EFFECT of the impact of the national defense program on the metals and associated industries was outstandingly evident at the exposition of the American Society for Metals held this year in Cleveland. Undoubtedly many of the developments prominent among the various exhibits at the show were not originally inspired by the armament motive. However, it is a high tribute to the exhibiting companies that the qualities of precision, speed and economy in manufacture, now so essential to the success of the defense program, are the very ideals toward which these industries were striving before the war.

As industry has shifted into high gear in co-operation with the federal government on the engineering and production aspects of national defense, new emphasis has been placed on the necessity for the conservation of those metals and alloying constituents the availability of which may be impaired by war in Europe and the far east. Of greatest strategic importance among these materials are antimony, chromium, manganese, mercury, nickel, tin, tungsten, aluminum, platinum and vanadium. Although most of these materials are still available in sufficient quantities to satisfy present requirements, the possible exigencies which may result from the curtailment of their supply has added new impetus to the development of high strength low alloy steels and nonferrous metals and alloys as well as broader applications of these materials.

Significant also of this same trend is the increased stress placed on the development of metals capable of being machined at high speeds in order that the production tempo in the armaments industries may be raised still higher. At the same time, new tool steels making possible higher speeds and faster feeds received considerable prominence in the exhibit. These two parallel engineering advances are instrumental in accelerating the rate of metal fabrication even beyond its present high level.

Various abrasion, wear and corrosion resistant surface finishes demonstrated constitute notable achievements in the field of metals. Such processes as the electrolytic surface oxidation of aluminum has done much to enhance the bearing qualities of this material as used in internal combustion engine pistons and similar parts. Refinements in the process of nitriding steel result in greater accuracy in the control of hardness and the depth of case.

To circumvent the shortage of skilled labor by utilizing to the utmost the available unskilled but intelligent manpower, semiautomatic induction and flame hardening machines have been developed which require little more attention on the part of the operator than the replacing of a work piece and pushing a button. Observers at the exposition were shown how hardening of gears, cylinders, crankshafts, etc. by means of this equipment might serve to eliminate still another production bottleneck.

Increasing use of welding in the metal fabrication industries will receive new stimulus by the introduction of high speed welding equipment utilizing both the electric arc and resistance as well as the oxyacetylene processes. Evolution of such equipment as on display is also marked by the tendency to minimize the amount of skilled attention these machines require to hold their place in the production line.

Not only do these automatic machines facilitate the fabrication and processing of machine parts but their use also provides the engineer with more precise data for interpreting his designs in terms of production.

Sintering machine parts of powdered metal affords further opportunities for the conservation of material as well as fast production of precision pieces. Largely confined at present to small cams, gears, impellers and the like on which the production volume is high, rapid strides were shown to have been made in both the production of the metal and the development of molds so that this process is now opportunely at hand for utilization in the defense program.

New developments and applications of die casting, stamping, forging, extrusion and similar processes provide this country with engineering advances fully capable of supporting the common cause of national defense. (Illustrations courtesy Inland Steel Co.).

Professional Viewpoints

". . . practical discussion has weight"

To the Editor:

The writer has read with a great deal of interest the series of articles by R. E. Orton which have appeared in MACHINE DESIGN on the photoelastic method. The author has done a service to the engineering profession by pointing out the practical utility of stress optical observations. Heretofore much of the published material has come from academic circles in spite of the fact that many industrial organizations are using these procedures. Mr. Orton's discussion will carry weight which an academic paper cannot, however much it may deserve to do so.

Modifications of the photoelastic method necessary for the study of three-dimensional problems might have been mentioned more specifically. There now exists at least two methods by which such investigations may be carried out with reasonable accuracy. Since the author did not attach a bibliography, it might be mentioned that an excellent one appeared in a recent article, "A Review of the Photoelastic Method," by R. D. Mindlin, in the Journal of Applied Physics for April and May 1939.

Altogether, the series is to be highly commended and it is earnestly hoped that more contributions will appear from industrial sources. The photoelastic method is frequently the only alternative to empiricism, which latter may result in rather inefficient design, especially in the early stages of development.

—R. WELLER
Washington State College

". . . beam frame is superior"

To the Editor:

In view of the fact that several readers of my article in your November issue have asked why we discontinued the bar type and adopted the beam type of frame construction for our molding machines, it is possible that other readers would also be interested.

Cross sectional area of the beams illustrated in the article is equivalent to 180 square inches. In comparison, if a tie bar construction were used—tying the machine end members together with nuts instead of dovetailed joints—it would necessitate the use of four bars 7⅝ inches in diameter to equal the cross section of the replacing beams. To avoid sacrificing die space, the frame would necessarily be increased between 50 and 60 per cent. The beam constructed frame is permanent, and when parallel and perpendicular within two thousandths-inch accurate, it maintains this condition for the life of the machine.

In comparison to the beam frame, the tie bar frame uses large nuts to join the end members with the tie bars. The nuts must be long enough that sufficient threads are engaged to resist the shear stresses. This is costly and it is almost impossible to make the threads accurately on the nuts for each tie bar. Accuracy, however, is accomplished easily in joining the beams with the end members of the machine. Regardless of the care taken in assembling a tie bar frame, the entire frame misaligns when pressure is exerted, necessitating re-adjustment of the nuts. This adjustment has to be repeated occasionally because of changing molds or a necessary takeup in the thread due to constant and repeated applied pressure.

For these reasons and the others discussed in my article we consider the permanent beam frame construction superior to our former tie bar type frames, and consequently have adopted it on our latest type injection molding and die-casting machines.

—W. H. SCHWARTZ, Chief Engineer
Lester Engineering Company

". . . bolts cannot be too strong"

To the Editor:

Because some designers often neglect the importance of connecting rod bolts by treating them as secondary engine parts, they meet with much unpleasantness due to failure of these parts. Besides faulty design, however, sometimes breakage is due to poor workmanship, worn bearings with excessive clearance, or overrating the engine by increasing its speed.

Designing connecting rod bolts consists of ascertaining the size of section necessary to withstand the loading to which it will be subjected. This loading for single acting engines is of three distinct kinds. They are loads due to the inertia of the reciprocating parts; transverse or whipping loads; and loads that are present periodically, as at a major critical.

Transverse, or whipping, loads are due to the mass and transverse acceleration of the connecting rod, which will result in the deflection of the rod foot. Whipping effect is at a maximum very near the point

(*Concluded on Page* 92)

Gift to Industry
BOWER
ROLLER BEARING CO.
Detroit, Michigan

Men of Machines

R. D. MacCart

FORMERLY chief engineer of the Brewster Aeronautical Corp., R. D. MacCart has been appointed vice president of the organization. Mr. MacCart is a graduate of Massachusetts Institute of Technology and also the Engineering School of Harvard university. Prior to his connection with Brewster he was an aeronautical engineering officer of the United States navy with the rank of commander. His navy duty included aircraft inspection, construction and design with specialization in structural design, vibration, structural static and dynamic testing in the laboratory and in flight. Mr. MacCart is a former member of the National Advisory Committee for Aeronautics and several other government committees, and is a Fellow of the Institute of Aeronautical Science.

JAMES Y. SCOTT, who for some time has been executive vice president of the Van Norman Machine Tool Co., Springfield, Mass., has recently been elected president of the company.

He was born in Dundee, Scotland. In 1916 he became connected with the Van Norman company as a tracer, and advanced rapidly to draftsman and layout man. He was then made salesman and later was appointed as assistant to the president. His next position with the organization was that of general sales manager. From this post he was promoted to executive vice president, which position he occupied until his recent appointment as president. Mr. Scott is also general manager and treasurer of the firm. In addition to his connection with the Van Norman company he is director of Perkins Machine & Gear Co. of Springfield.

James Y. Scott

V. E. Carlson

ANOTHER rung in his engineering career was reached by V. E. Carlson in his recent appointment as chief engineer of the Eureka Vacuum Cleaner Co., Detroit.

Mr. Carlson is well known as an engineer in this field, having been connected with the Hoover Co., North Canton, O., for some time. He has devoted his efforts for the past ten years to the design and development of vacuum cleaners with the Hoover company, and has held various positions in the engineering division during his connection with this organization. At the time of his resignation Mr. Carlson was staff engineer, his duties covering all phases of design and co-ordination of the activities of the laboratories and production department on new cleaner developments.

Prior to his connection with the Hoover Co., he was affiliated with Federal-Mogul Corp. in its engineering department where he designed

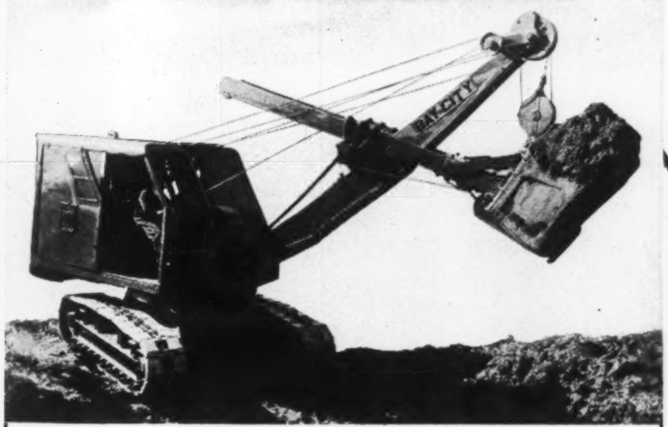
MORE STRENGTH TO MEET STRESS...

50 *places in a power shovel...*

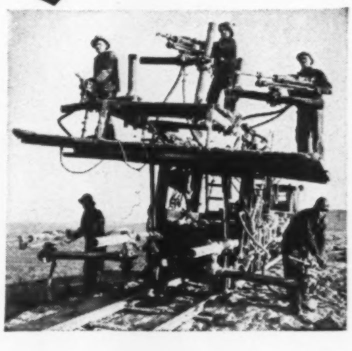
85 *places in a rock drill...*

275 *places in a milling machine*

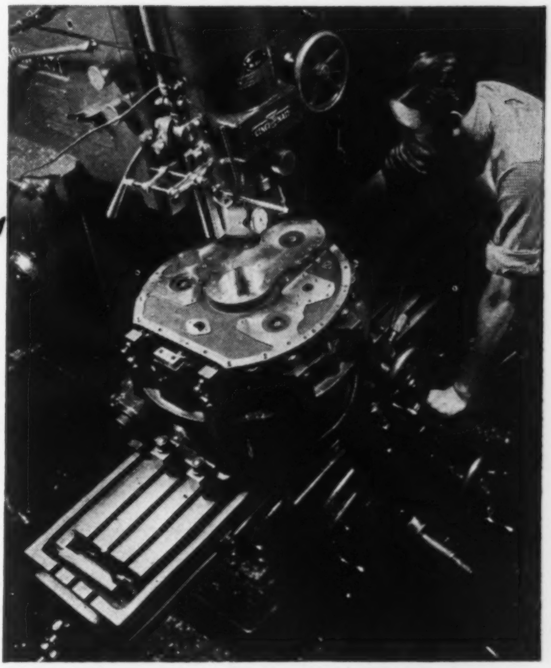
NICKEL ALLOY STEELS



Measured by weight, nearly ⅓ of this Bay City power shovel is fabricated from long-wearing Nickel alloy steels. 50 vital parts which must withstand fatigue strains, shock stress and overloads are made of SAE 3135 oil quenched Nickel-chromium steel and other Nickel alloy steels. Frames and bases are Nickel cast steel. "Chabelco" crawler drive chains, Diamond crowd chain, Hercules gasoline and Caterpillar Diesel engines on Bay City shovels also employ high strength Nickel alloy steels for important stressed components.



Here are five Gardner-Denver rock drills mounted for tunnel driving. In each drill, 85 stressed parts are produced from Nickel alloy steels. The Gardner-Denver Co. writes, "Through increased use of Nickel alloy steels, remarkable improvements in performance and reduction in maintenance costs have been accomplished—without comparable increase in weight or bulk."



More than 275 stressed parts in this dial type Cincinnati milling machine are Nickel alloy steels. Nearly 200 of these parts are made of a Nickel-chromium steel, heat treated to high strength yet readily machinable. Parts subject to wear are case-hardened.

• • •

➡ Purchasing and production are often simplified because the versatility of Nickel steels usually permits one Nickel steel to efficiently serve many purposes. Practical answers to your inquiries will be given promptly, based upon our broad experience with many industries. Please address:

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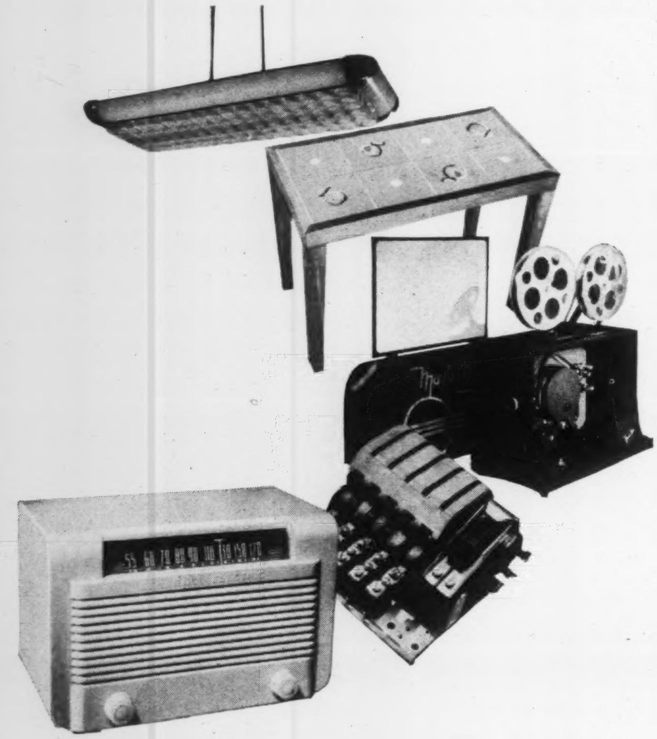


Again

FIVE TOP AWARDS

AGAIN, the G-E Plastics Department earned first honors in the Modern Plastics Competition with five top awards . . . By proper application of Textolite, John C. Virden Company was honored for its fluorescent lighting fixture, Movie-Mite Corporation for its sound-movie projector, Alice Donaldson for her Plasdecor table top, and General Electric for both its 1941 radio and a contactor shaft . . . Each of G.E.'s four plastics plants contributed a winner and each of its sections—material manufacturing, hot and cold molding, laminating and fabricating—was represented in the awards.

PLASTICS DEPARTMENT
GENERAL ELECTRIC
PD-701

special tools and fixtures for the manufacture of bearings for the automotive industry.

◆

WILLIAM SPRARAGEN, technical secretary of the American Welding Society and editor of *The Welding Journal,* recently was the recipient of the Samuel Wylie Miller medal awarded by the American Welding Society. The Lincoln medal was awarded to H. J. FRENCH and T. N. ARMSTRONG JR. of International Nickel Co. Inc.

◆

FRED T. MACRAE JR. has been elected executive vice president of White Motor Co.

◆

L. R. KELLS has been placed in charge of the furnace department of Wellman Engineering Co., Cleveland. Mr. Kells has heretofore been chief engineer of Salem Engineering Co. and has considerable experience in designing furnaces.

◆

JACK F. WOLFRAM has been appointed assistant chief engineer in charge of engine transmission and axle design of Oldsmobile division, General Motors Corp., Lansing, Mich. He was formerly experimental engineer. From chassis engineer, MAURICE A. THORNE has been promoted to assistant chief engineer in charge of body, chassis, electrical and accessory groups. JOHN OSWALD, who has been body engineer since 1929, has been named director of styling.

◆

DONALD B. PRENTICE, a member of American Society of Mechanical Engineers, has been elected president of the Society for the Promotion of Engineering Education.

◆

HENRY T. HEALD, who for two years had been president of Armour Institute of Technology before its merger with Lewis Institute, has been elected president of the new institution, the Illinois Institute of Technology.

◆

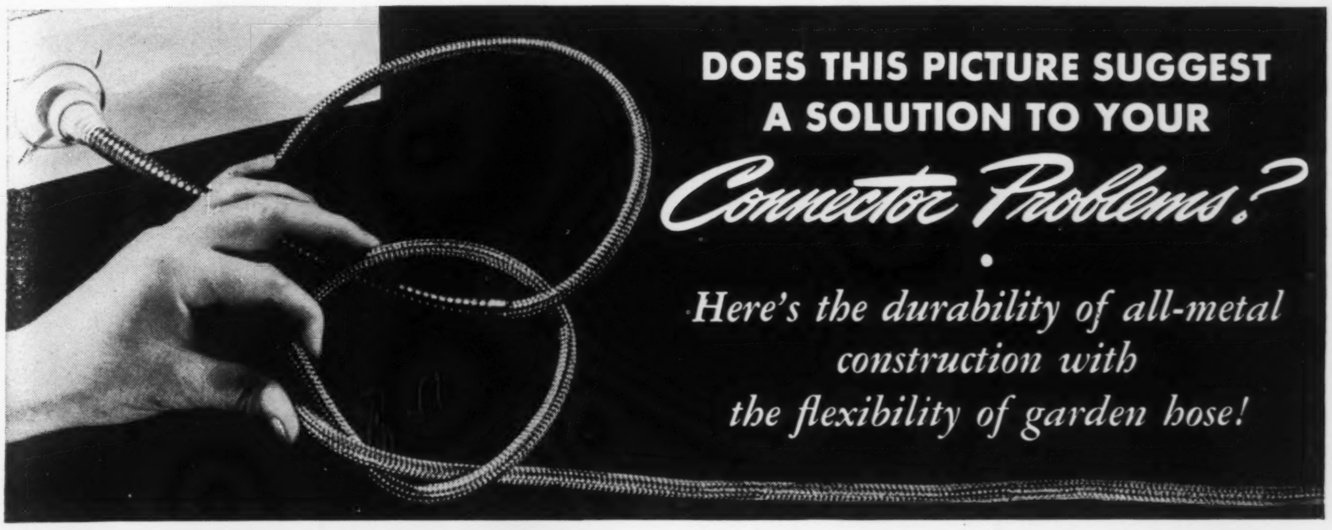
GLENN L. MARTIN, president of The Glenn L. Martin Co. has been awarded the Daniel Guggenheim medal for 1940 which will be presented at Honors Night dinner of the Institute of the Areonautical Sciences "for contributions to aeronautical development and production of many types of aircraft of high performance."

◆

DELMAR G. ROOS, chief engineer of Willys-Overland Motors Inc., has been elected to the board of directors. Mr. Roos, who joined this company in 1938, designed the new American line of Willys motor cars for 1941.

◆

ROBERT PAXTON, formerly managing engineer of the panel and equipment division at the Philadelphia works of General Electric Co., has been named assistant to works manager. Other appointments at the Philadelphia works include that of HAROLD E. STRANG as engineer of this office, L. S. HOBSON as managing engineer of the power circuit breaker division and GEORGE



DOES THIS PICTURE SUGGEST A SOLUTION TO YOUR *Connector Problems?*

•

Here's the durability of all-metal construction with the flexibility of garden hose!

↑ To protect the delicate capillary tubing of this recording instrument American's capillary casing tubing was chosen. Made especially for the purpose, it assures protection from any physical damage. It is flexible metal, strong and tough. Like most other American products it's available in many different alloys.

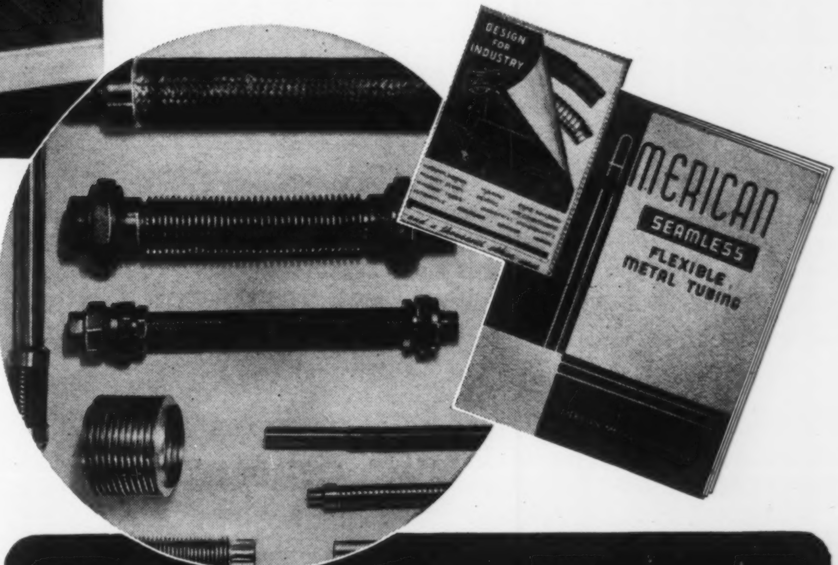
•

← By eliminating swing joints and standardizing on American Seamless for steam connections, many pressing machine manufacturers have increased operator efficiency and the production efficiency of the press. American Seamless is as free from leaks as the seamless tube from which it is made. It has no laps, seams or welds of any kind, making it absolutely pressure tight—*never requires packing of any kind.*

→ These and hundreds of other problems involving flexible metal connectors have been solved by the products of American Metal Hose. The books illustrated to the right, will bring you complete and detailed information on American Metal Hose and Seamless Tubing. In their pages you are sure to see many applications that will suggest a solution to your problems. A note will bring your copies by return mail.

40251

ANACONDA



American Metal Hose

THE AMERICAN METAL HOSE BRANCH of THE AMERICAN BRASS COMPANY
General Offices: Waterbury, Conn. • Subsidiary of Anaconda Copper Mining Company
in Canada: Anaconda American Brass Ltd., New Toronto, Ont.

VAPOR PRESSURE-TEMPERATURE
New
VAPOR
PRESSURE
temperature
CHART

20" x 30" Suitable for Mounting, Covering 35 Thermostatic Filling Liquids . . . . .

We have just published our engineering department chart, recording the relation between vapor pressure and temperature of a large number of thermostatic filling liquids.

The compilation of this chart required practically an entire year of intensive work on the part of our laboratories, and the information will, we believe, be invaluable to laboratories or engineering organizations requiring such data.

A limited quantity of these charts is available for those seriously interested. Address your request to

CLIFFORD MANUFACTURING COMPANY
Producers of
HYDRON METALLIC BELLOWS
564 East First Street, Boston
221 North La Salle Street, Chicago
6432 Cass Avenue, Detroit

M. Reed as managing engineer of the panel and equipment division.

◆

Eugene R. Perry, who has been associated with Westinghouse Electric & Mfg. Co. since 1929, has been promoted to manager of engineering and superintendent of the Micarta works of the company at Trafford, Pa. For seven years after joining the company he specialized in studies of resins, and in 1936 was transferred to the Micarta works. Two years later he became engineering manager.

◆

E. W. Ritter, former general manager of radio tube manufacturing, has been appointed vice president in charge of RCA's manufacturing and production engineering activities. He joined the Nela Park branch of General Electric and from there transferred to the research and development engineering division of RCA Radiotron in 1930, becoming head of the department in 1934. Four years later he was made manager of the entire division and early this year, manager of engineering, in addition to his Radiotron activities.

◆

Dr. E. O. Buckley, since 1936 executive vice president of Bell Telephone Laboratories, has been named president to succeed Dr. F. B. Jewett, now chairman of the board. Dr. Buckley became affiliated with the Bell system in 1914 and was made director of research in 1933.

◆

E. C. Herrington, formerly chief engineer for Herrington & Randall Inc., was recently named head of the expanded industrial oven division of Ferro Enamel Corp.

◆

Dr. Claude L. Clark has joined the staff of the steel and tube division of Timken Roller Bearing Co. as metallurgical development engineer. Dr. Clark was formerly a member of the department of engineering research at University of Michigan and for the past ten years has conducted research studies of the properties of metals at elevated temperatures.

◆

Frederick V. Geier of Cincinnati Milling Machine Co. has been elected president of the National Machine Tool Builders' association. Clifford Stilwell of Warner and Swasey becomes vice president.

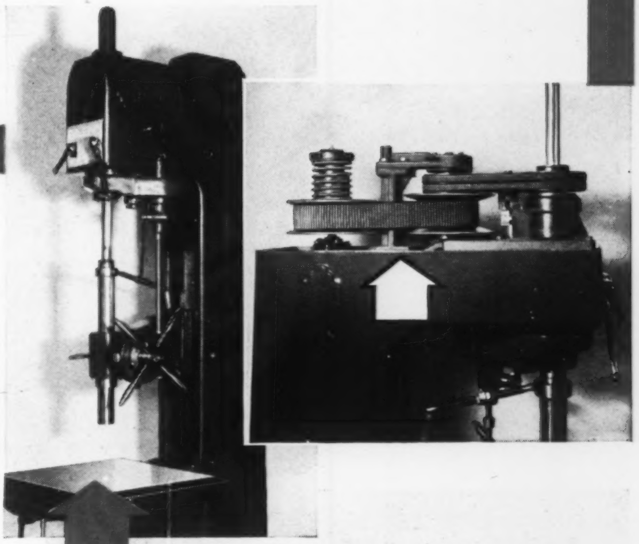
◆

Theodore P. Wright, vice president in charge of engineering for the Curtiss-Wright Corp., has been made chairman of the newly-created S.A.E. Aeronautical Standards Board for National Defense. The new board will undertake a co-operative program of development and co-ordination of aircraft standardization in connection with the defense program.

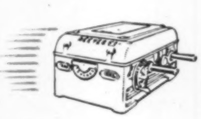
◆

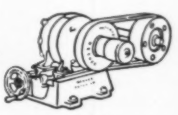
Dr. C. Guy Suits, a member of the General Electric research laboratory staff since 1930, has been appointed assistant to Dr. W. D. Coolidge, director of the laboratory. He will continue his research while assuming some administrative duties.

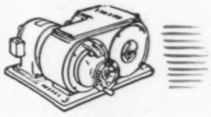
How Reeves Makes It EASY *to Incorporate Speed Control* CORRECTLY



EXAMPLE: To provide this modern drill press with complete speed flexibility, the manufacturer uses the REEVES Motodrive internal operating parts (without case) installed within the head of the press. *Above, right:* head removed to show installation of this space-saving REEVES unit which combines motor, speed varying mechanism and (if required) reduction gears. REEVES also offers Transmission operating parts only (without frame) for incorporating in design of a machine.

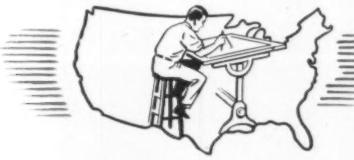

Transmission


Motor Pulley


Motodrive

COMPLETE LINE OF ADAPTABLE UNITS

These are the three basic units around which Reeves builds a complete line of modern, compact variable speed control equipment—a wide range of designs, controls, sizes to 78 h.p. and speed ratios 2:1 through 16:1. Machine builders who adopt Reeves Speed Control are free from the limitations imposed by one standard design. You can plan your application from the most practical and economical standpoints, to meet your needs exactly.



NATION-WIDE ENGINEERING STAFF

Located in 35 industrial centers are factory-trained, seasoned Reeves engineers prepared to counsel with you on factors calling for thorough and careful judgment—speed variations, horsepower requirements, available space, driving connections, methods of control.

BROADEST EXPERIENCE IN THE FIELD

You benefit by Reeves unequalled experience in providing speed control as standard equipment on 1,376 different makes of machines. More than 140,000 Reeves units are now in service in over 18,000 plants. From no other source can you obtain so much practical experience.

SPEED CONTROL EXCLUSIVELY

REEVES SPECIALIZES IN SPEED CONTROL

Variable Speed Control is a specialty with Reeves—not a side-line. Reeves "lives" speed control. That's why we can offer a complete line of units instead of only a few standard models. That's why you get prompt action on your requirements.

★ ★ ★

Send today for copy of 124-page Speed Control Manual and Catalog G-397, which describes Reeves *units and shows how machine builders are incorporating them as standard equipment to release the full capacities of their machines.*

REEVES PULLEY COMPANY, *Dept.* H, COLUMBUS, INDIANA

REEVES ACCURATE POSITIVE **SPEED CONTROL**

FOR YOUR STOCK GEAR NEEDS

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"Off-the-Shelf Service"

Hurry, Hurry! Meet America's demand for more machines. Take the shortest cut to faster production on the machines you build. Save time, labor and cost. You can do it by utilizing stock gears and reducers. That's the sure way to cut one bottle neck in machine production.

For quick action on every type of stock gear or speed reducer, call the nearest Ohio Gear representative. Thousands of types and sizes are ready for immediate shipment to you. An Ohio Gear catalog will help in your selections. Send for one now.

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OHIO GEARS

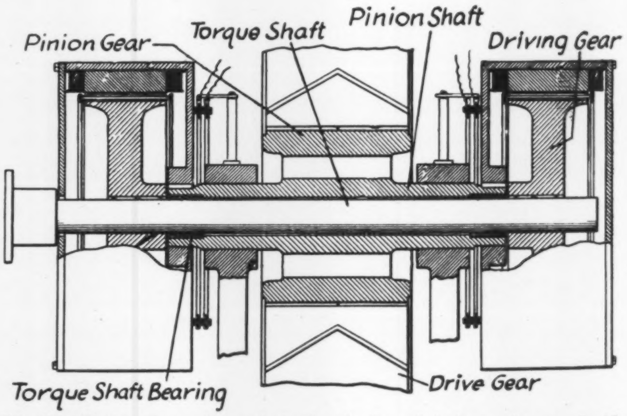
Noteworthy PATENTS

Magnetic Couplings Balance Load

ELIMINATION of unbalanced bearing loads as well as the attainment of uniform gear engagement is achieved by the use of two magnetic slip couplings, one on each side of the pinion gear.

Developed primarily for marine propulsion units in which two power sources, such as diesel engines, are each connected to a main propeller shaft by means of drive pinions diametrically opposed on the main drive gear, the invention possesses evident advantages wherever it is essential that the torque load be balanced on both ends of a drive shaft.

Power source is connected to the left end of the torque shaft. Keyed to either end of this shaft are driving rotors of the magnetic slip couplings. External to, and concentric with the torque shaft is the pinion shaft which carries two torque shaft bearings. This pinion shaft is driven through the two field windings of the magnetic clutches.



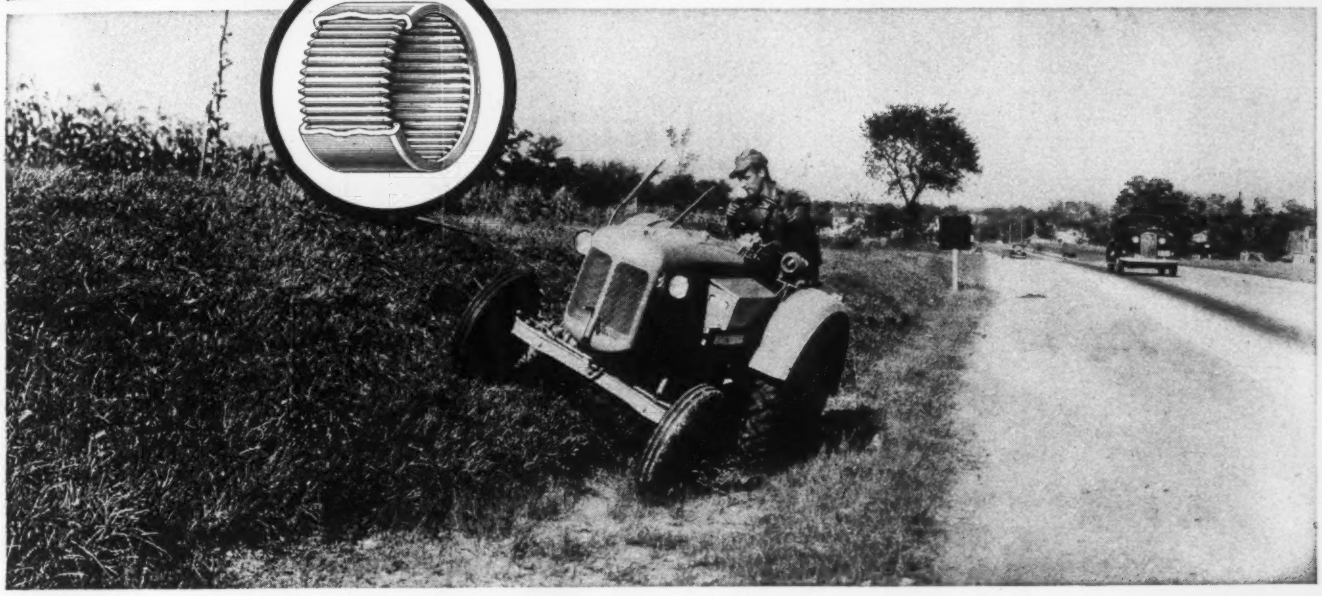
Shaft distortion is minimized by driving from both ends of the shaft through the two magnetic couplings

Permitting the use of considerably smaller couplings, the arrangement illustrated has a combined output equal to a much larger single coupling at one end of a pinion shaft. The patent is assigned to Farrel-Birmingham Co.

Brake Prevents Motor Overrunning

OVERRUNNING of electric motors used for operating such indexing equipment as railroad track switches and the like is prevented by a solenoid-operated friction brake capable of being built into the

"TORRINGTON NEEDLE BEARINGS TAKE HEAVY ROTATING AND OSCILLATING LOADS EFFECTIVELY" IN CENTAUR HI-WAY MOWER



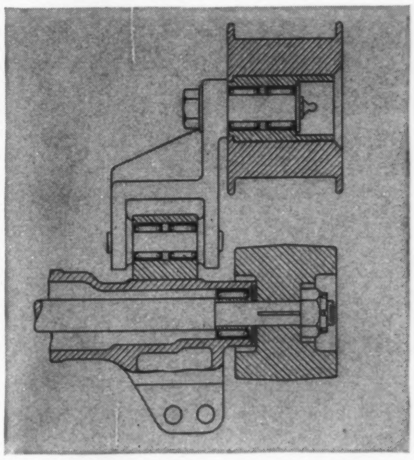
Eleven applications of the Needle Bearing help to reduce friction, increase operating efficiency and add to the service-life of this Model KM Centaur Hi-Way Mower.

SWAYING and lurching up-ditch, down-ditch, over slopes, fills and embankments—and most of the time at an acute angle—the popular Centaur Hi-Way Mower plies its job of keeping road-borders clear of weeds and other unsightly growths that mar the beauty and impair the safety of modern highways.

As can be appreciated, such rough and tumble service imposes severe strain on every component part of this motorized mowing unit. Therefore, the long service-life of the Model KM Centaur is adequate testimony to the skilled engineering construction with which it is built, and the care with which integral parts are selected.

The Torrington Needle Bearing is no exception to this rule. According to Mr. E. A. Cross, Superintendent of the Centaur Corporation, "The Needle Bearing was selected because it is economical in cost, simple to install, requires minimum space in cramped locations, retains lubrication well, and withstands heavy rotating and oscillating loads effectively.

"All told," adds Mr. Cross, "eleven applications of Torrington Needle Bearings are used on Centaur KM and RW mowing equipment. In three applications of the Needle Bearing, Torrington inner races* are used as 'bushings' to withstand heavy oscillating shock loads and have proved very efficient."



Typical of these applications is the mower drive shaft, belt tightener, pulley and bracket which illustrates the compact design permitted by Torrington Needle Bearings.

When any manufacturer selects the Needle Bearing for as many of its features as has the Centaur Corporation, there is very little that we can add. Except, perhaps, to stress its ready adaptability to product design, which frequently results in marked savings in weight, space and cost. That, plus the suggestion that *you* translate these remarkable manufacturing and operating advantages into terms of *your* product, to appreciate why so many leading manufacturers have adopted this revolutionary anti-friction development.

For further information write for Catalog No. 9. For Needle Bearings to be used in heavier service, request Booklet 103X from our associate, the Bantam Bearings Corporation, South Bend, Ind.

*Where a hardened shaft is not feasible, a Torrington hardened inner race can be supplied.

The Torrington Company
ESTABLISHED 1866
Torrington, Conn., U.S.A.
Makers of Needle and Ball Bearings
New York Boston Philadelphia Detroit
Cleveland Chicago London, England

TORRINGTON NEEDLE BEARING

A Full Range of Sizes

● Twin Disc Model MT Machine Tool Clutches are furnished in a full range of sizes to meet every need: 3″, 3½″, 4″, 4½″, 5″, 5½″, 6″, 7″ and 8″ in diameter. The working capacities of the various sizes range from 573 in.-lbs. for the 3″ dry type clutch to 9,618 in.-lbs. for the 8″ dry type. The capacities for the wet, or oil type, range from 296 in.-lbs. for the 3″ size to 7,857 in.-lbs. for the 8″ clutch.

Where clutches of larger diameter are required, the Model CC Clutches are available in wet and dry types, in sizes up to 12″ in diameter.

Write for recommendations.

RIGHT: *Twin Disc Model MT Single Machine Tool Clutch.*

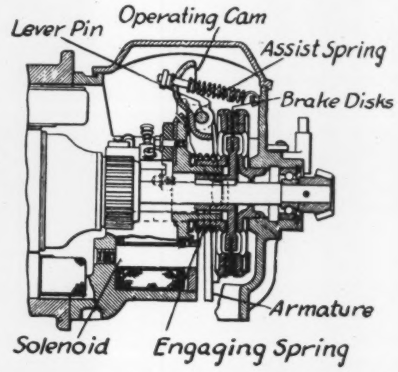
BELOW: *Twin Disc Model MT Duplex Machine Tool Clutch.*

TWIN DISC CLUTCHES
REG. U. S. PAT. OFF.

TWIN DISC CLUTCH CO. • 1325 RACINE ST. • RACINE, WIS.

motor housing. Two solenoids, one of which is shown in the accompanying sectional view, are located on either side of the base of the motor housing. The solenoids are electrically connected in series with the motor so that when power is supplied the solenoids are energized, releasing the brake. The two cams, which serve to affect axial movement of one of the brake disks, are so formed as to vary the solenoid load in inverse proportion to the distance of the armature from the magnet.

Two friction brake disks are mounted concentric with the motor shaft; one stationary with the housing, the other, splined to the motor shaft and capable of axial movement under the impulse of the operating cam. Integral with the cam are two operating levers which, at their lower ends, constitute the armatures for the solenoids.

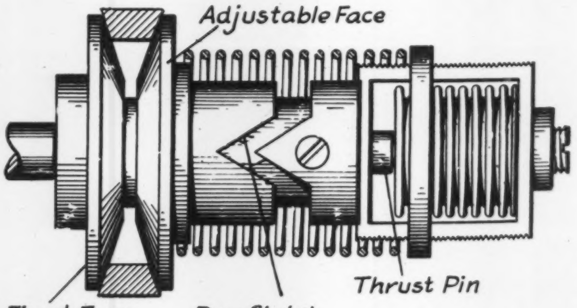


Solenoid - operated brake disks quickly stop the rotor when motor is disconnected from the line

Opposing the engaging spring are a pair of adjustable assist springs mounted on the operating levers in such a manner that the normal load on the brake disks when the solenoids are de-energized is controllable. This auxiliary brake patent for motors is assigned to the Union Switch and Signal Co.

Bellows Controls Speed

METALLIC bellows-actuated variable pitch pulley assembly provides a thermostatic regulation of speed without external controls. The bellows is constrained on floating centers so that all torsional stresses are eliminated. Hub of the adjustable face is machined to a sliding fit on the outside of the hub of the fixed face which extends through it and carries the bellows



Designed to increase belt speed with increasing temperature, converse achieved by minor redesign

MAZLO
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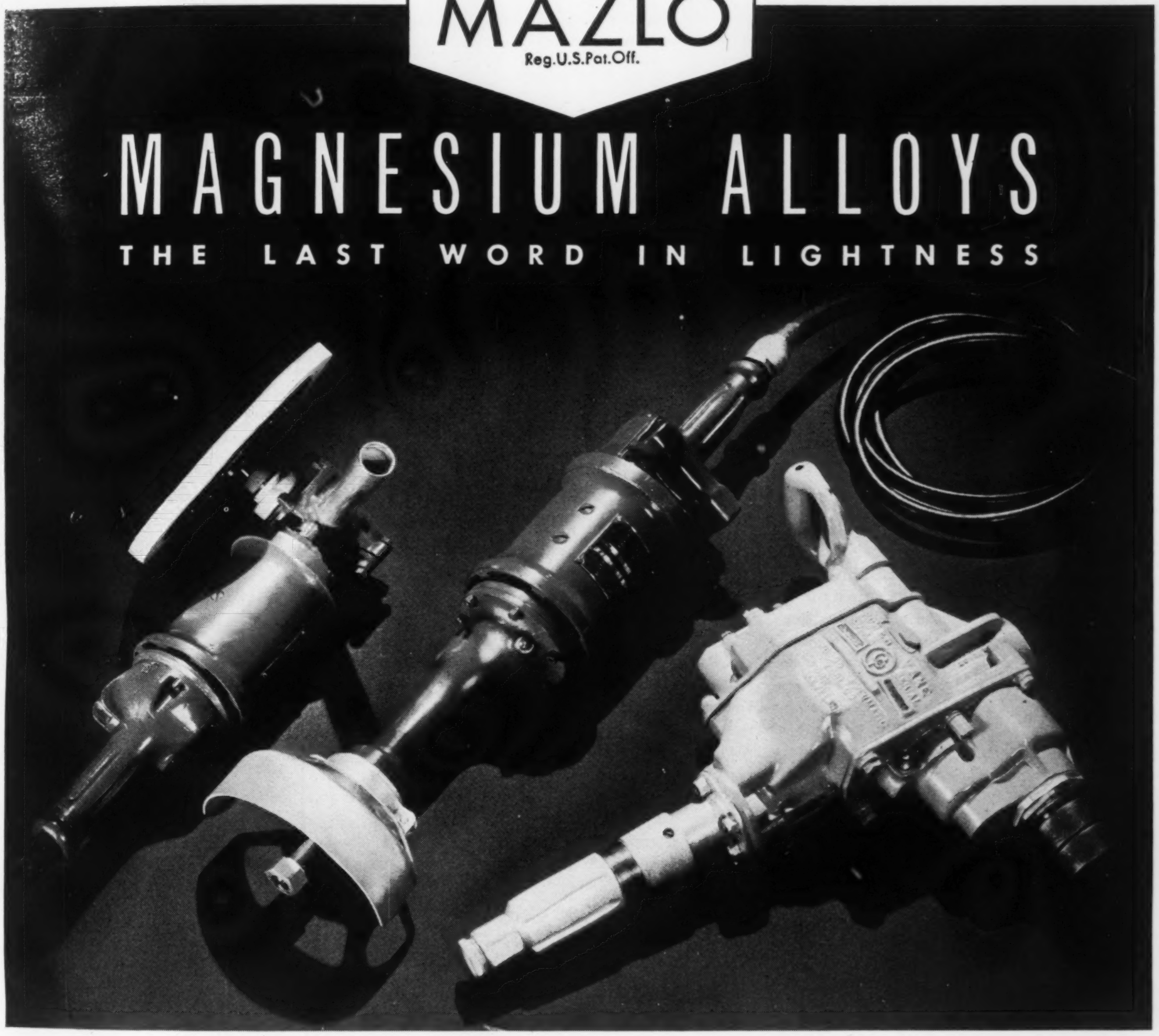
MAGNESIUM ALLOYS

THE LAST WORD IN LIGHTNESS



Built for Man-Handling

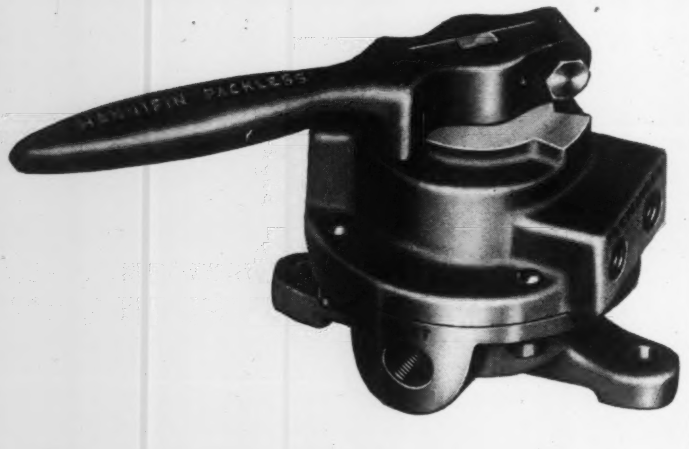
MAZLO Magnesium parts make these CP electric and pneumatic portable tools much lighter in weight. Workers using them save considerable effort, ordinarily wasted. Jobs go faster, with less fatigue.

Strong MAZLO Magnesium Alloys are used by Chicago Pneumatic Tool Company in building these tools. They have the toughness and stamina demanded by the grinding, sanding, drilling and nut-running jobs they're set to do.

Reducing weight that has to be moved, by man or machine, allows that action to be speeded up. It cuts wear and tear on the mover. That is why both men and machines like the lighter weight of MAZLO Magnesium Alloys. Sales Agent: Aluminum Company of America, 1703 Gulf Building, Pittsburgh, Pennsylvania.

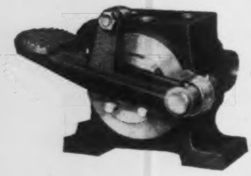
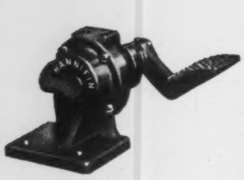
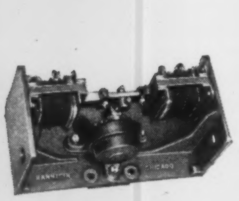
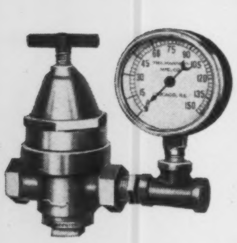
MAZLO
Reg. U.S. Pat. Off.

AMERICAN MAGNESIUM CORPORATION



GET MORE EFFICIENT USE OF AIR POWER . . .

with positive control

Hannifin "Pack-less" Air Control Valves give you positive, accurate control of air power, with smooth, easy handling of air operated equipment. Their simple disc-type design avoids leakage and waste of air, gives uniform action that contributes to faster production. The bronze disc controlling air flow is ground and lapped to make a perfect seal with the seat, which is similarly finished. Wear is negligible, there is no leakage or packing maintenance trouble.

Hannifin valves are made in 3-way and 4-way types for various standard cycles of operation, for control of single and double-acting cylinders. Built in the following models: Standard 3-way and 4-way hand control valves; Duplex valves for control of two double-acting cylinders; Spring return for instant reversal upon release of pedal; Heavy-duty rotary valves; Foot operated treadle valves; Electric models for remote control; Manifold types for control of several units.

Also piston type pressure regulating valves for providing uniform and most economical operating pressures for individual machines.

Write for Valve Bulletin 34-MD with complete specifications of all types.

HANNIFIN MANUFACTURING COMPANY
621-631 SOUTH KOLMAR AVENUE • CHICAGO, ILLINOIS
ENGINEERS • DESIGNERS • MANUFACTURERS
Single and double-acting pneumatic and hydraulic cylinders

•

HANNIFIN VALVES

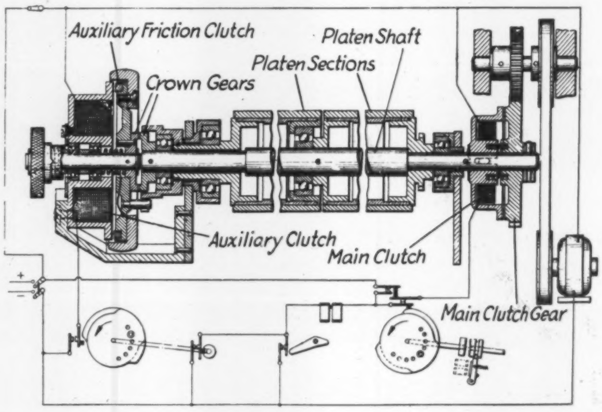
cage. A compression spring between the bellows cage and the adjustable pulley face insures immediate speed change with temperature change of the thermostatic element. The thrust pin which is free in the fixed pulley hub carries a cross pin which engages the hub of the movable pulley. A V-type dog clutch is used so that the spring, rather than the bellows, will absorb torsional load shocks. This patent is issued to W. W. Hallinan.

Magnetic Clutches Effect Feed

TWO magnetic clutches effect concerted or independent rotation of the two halves of the split platen of a billing machine intended to print individual items on one sheet and totals on another.

Constantly rotating main clutch gear carries a friction surface on its left face, which, when the main clutch magnet is energized, drives the platen shaft through the co-operating clutch surface. The platen section on the right, being fastened to the shaft, turns with it.

The left platen section is connected through the crown gears to the auxiliary clutch. In the position shown the magnet is de-energized and the crown gears are maintained in engagement by the clutch spring. In this position both platen sections turn as a unit either automatically or by manual operation. However, when the magnet is energized the crown gears are disengaged, thus disconnecting the left-hand platen section from the shaft. At the same time the auxiliary friction clutch is engaged, permitting only the left-hand platen to be rotated manually if desired. The patent is assigned to the International Business Machines Corp.



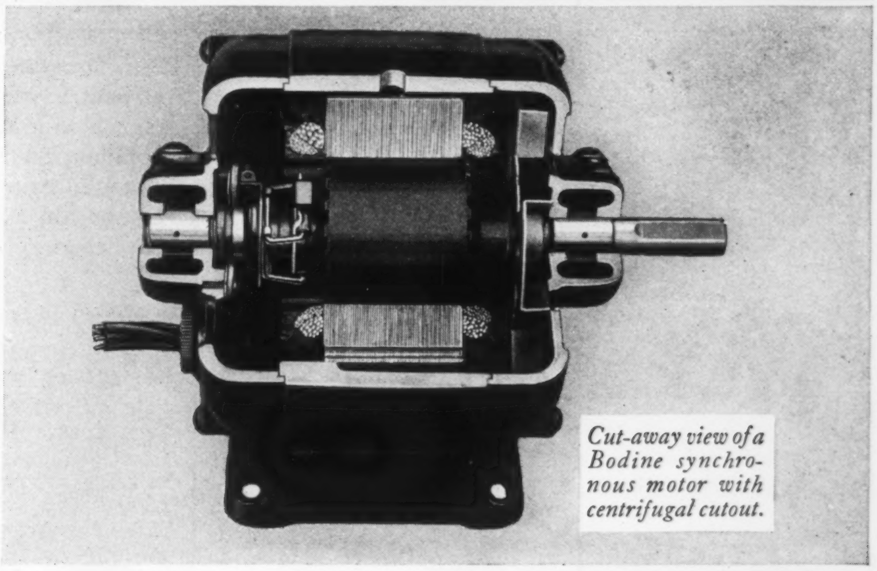
Power or manual operation of either or both platen sections is achieved by two magnetic clutches

Piston Valve Provides Speed Control

RAPID approach, slow feed and quick return motion of a milling machine table is achieved by the unusually simple hydraulic control illustrated. The table is attached to the end of the piston rod which passes through the head of the hydraulic cylinder. As shown, the working stroke of the table is

Facts you need to know about small SYNCHRONOUS MOTORS

Number Four of a series on "How to Select a Small Motor for your Machine"



Cut-away view of a Bodine synchronous motor with centrifugal cutout.

Synchronous motors are generally employed for driving apparatus whose speed must be accurately maintained. They are widely used in large clocks, X-ray timers, recording instruments, and sound cameras.

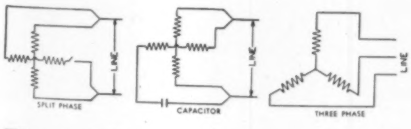
Principle of Operation

Like most a-c motors, the synchronous motor employs a squirrel-cage rotor and a distributed stator. It starts as an induction motor but has a salient-pole rotor, which pulls the motor into step as it nears synchronous speed.

Synchronous motors are available with three types of windings: split-phase, capacitor, and polyphase. The split-phase synchronous motor is provided with windings similar to the split-phase induction motor. A cutout disconnects the starting winding when the motor approaches synchronous speed. Because of its low cost, high starting torque, and relatively high efficiency, this is the most commonly used single-phase synchronous motor.

The capacitor synchronous motor is a single-phase induction motor with a capacitor to provide starting torque. As the capacitor motor has no centrifugal cutout, it is extremely reliable, quiet in operation, and comparatively free from vibration.

The three-phase synchronous motor is usually preferred where three-phase current is available. It has a higher starting torque and a lower starting current than single-phase synchronous motors. It requires no centrifugal cutout switch.



Three popular types of synchronous motors

Characteristics

The predominant characteristic of all synchronous motors is their absolutely constant speed. This speed is determined by the frequency of the power supply and will be maintained at all loads within the range of the motor.

Synchronous motors have a fairly good starting torque. This varies with the position of the rotor. For certain positions, the motor will develop a very high torque. Their rating should, therefore, be based upon their minimum starting torque.

Synchronous motors vibrate more than non-synchronous a-c motors. As the cause of this vibration is electrical, it is present even though the rotor is both statically and dynamically balanced.

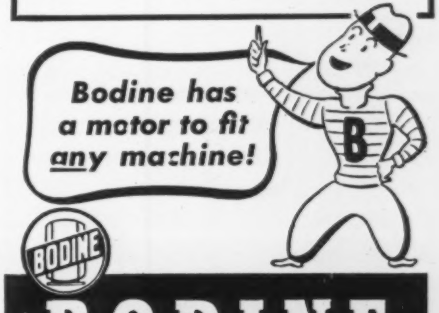
Bodine Synchronous Motors

Bodine synchronous motors are available in split-phase, capacitor, and polyphase types, in capacities ranging from 1/2000 to 1/5 hp. These motors run at 1800 rpm on 60 cycles. Also with speed reducers. Modifications can be provided to order. Write for Bulletin 2025.

BODINE BUILDS MOTORS OF EVERY KIND

Bodine offers you more standard types of fractional horsepower motors than any other manufacturer. In addition to a full line of synchronous motors, Bodine makes split-phase, capacitor, shaded pole, and polyphase induction a-c motors; shunt and compound d-c motors; and series universal motors. These may be provided with built-in speed reducers, governors, thermal-protectors, special mountings, and many other features. These motors are reliable, smooth-running, quiet, and efficient.

Over 3000 Types • 1/2000 to 1/6 Hp


Bodine has a motor to fit any machine!
B

BODINE
FRACTIONAL HORSEPOWER
MOTORS
ENGINEERED FOR YOUR PRODUCT

Bodine synchronous motors can be supplied with SPEED REDUCERS

BODINE ELECTRIC COMPANY • 2258 W. OHIO ST., CHICAGO

TRY THEM!

FREE SAMPLES

BRISTO SOCKET SCREWS

Convince yourself that Bristo's faster, easier, tighter set-up means speedier assembly, stronger construction, minimum assembly cost. All you have to do to get Bristo Socket Screws for an "on-the-job" try-out, is to mail in the handy coupon below. It brings you a tidy selection of Bristo Screws and Wrenches for you to set up—either on your products or your production machinery.

BRISTO'S THE CHOICE . . . *for good reasons!*

These easy-to-handle socket screws set up tighter, and with less effort. And they stay tight, too,—holding with a grip that defies vibrations. The exclusive fluted design of the socket head permits greater force without weakening, without danger of stripping or rounding out. Time and again a Bristo can be backed off and retightened without damage to the socket. Use of a Bristo reduces necessity of frequent replacements. Assembly time is saved. No wonder so many manufacturers have standardized on Bristos!!

MAIL THIS COUPON!

Free Bristo samples, and Bulletin 83-8N which gives you facts on these labor-saving screws, are ready for you. Send for both today. The Bristol Company, Mill Supplies Division, Waterbury, Conn.

QUICK BRISTO FACTS

Lock-tight socket head, won't split, shear, round out, jam or strip . . . Set tighter with less effort. . . . No loosening under vibration. Take wrench without fumbling . . . or skidding.

BRISTO

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SOCKET SCREWS

THE BRISTOL COMPANY, Mill Supplies Division
Waterbury, Conn.

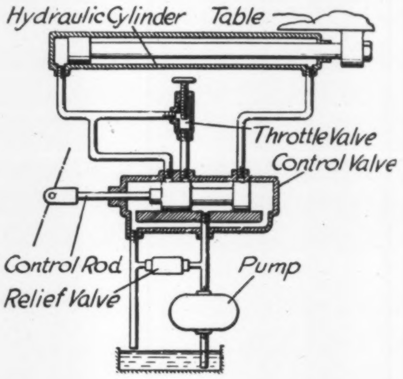
Send me sample Bristo Socket Screws and Bulletin 83-8N.

Name______________________________

Address______________________________

to the right; return, to the left. Speed control is obtained by means of a valve in which is mounted a double-ended piston. Oil is supplied under pressure to the chamber between the ends of the piston. Predetermined pressure is maintained in this chamber by the relief valve which opens to permit the pump to recirculate when the operating pressure is reached. Timing of the motions is effected by means of a control rod which may be operated mechanically or by solenoids.

In the position shown, the control valve piston is in the neutral position and the table is stationary. When this piston is moved all the way to the left both ports supplying the conduit leading to the left end of the hydraulic cylinder are opened to the pressure chamber and the conduit leading from the right end of the cylinder is opened to the sump. Thus the piston and the table are moved rapidly to the right. As the work nears the cutter, the control valve piston is moved sufficiently to the right to cover the port of the left branch of the supply conduit. Pressure fluid then passes through the throttle valve to the left end of the hydraulic cylinder resulting in a slow motion of the table. At the end of the stroke the control valve piston is moved completely to the right opening the right hand conduit to the pressure chamber and the left hand conduit to the sump. Rapid return motion of the table to the left results and the cycle is repeated. The patent is assigned to the Ingersoll Milling Machine Co.



Two speeds forward and one in reverse are obtained by hydraulic control of milling machine table

---

Definite relationship between the creep strength of steel and its microstructure has been established by S. H. Weaver of the General Electric turbine engineering department.

Studying carbon-molybdenum steel, one of the important alloys in turbine manufacture, he found there is an optimum grain size of the metal which produces the maximum creep strength at each creep temperature.

For steels of the same chemical composition, the finest grained possesses maximum strength at low creep temperatures, at intermediate temperatures a medium grain size has the greatest strength and at high temperatures maximum strength is obtained by the coarsest grained steel.

ASSETS to a BOOKCASE

Materials Handbook

By George S. Brady; published by McGraw-Hill Book Co. Inc., New York; 563 pages, 6 by 9 inches, cloth bound; available through MACHINE DESIGN *for $5 postpaid.*

General information on all kinds of materials is given in the fourth edition of this volume, which makes no attempt to be exhaustive. The author assumes that designers will want to confer with producers of materials for detailed specifications.

As far as it goes, however, the information is sound, and will provide engineers with enough information to permit tentative decisions as to the suitability of particular materials.

Chief virtue of the volume, of course, is its comprehensiveness. The majority of materials mentioned have applications in machines. A few typical examples of obscure metals will illustrate the breadth of the book: Aich's metal, Badin metal, Constantan, Germanite, Norskalloy, Sperrylite, Victor metal.

□ □ □

The Working, Heat Treating, and Welding of Steel

By Harry L. Campbell; published by John Wiley & Sons Inc., New York; 189 pages, 6 by 9 inches, cloth bound; available through MACHINE DESIGN *for $2.25 postpaid.*

Main value to the designer of the second edition of this textbook is as a review and classification of steel and its alloys. Fortunately, the subject matter is not as concerned with production processes as the title would indicate. Of particular interest is the last chapter, which reviews methods for protecting steel from corrosion.

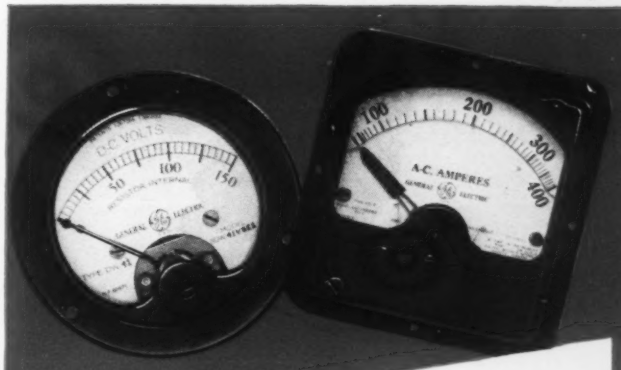
Although primarily for students, the book has plenty of solid information for engineers wishing more knowledge of metallurgy. In this connection Chapter 5 on the physical constitution of steel will be helpful. Effects on grain size and steel properties of temperature changes and mechanical working are covered in Chapter 6, another especially useful one.

□ □ □

Sales Engineering

By Bernard Lester; published by John Wiley & Sons Inc., New York; 200 pages, 5½ by 8½ inches, cloth bound; available through MACHINE DESIGN *for $2 postpaid.*

Designers will find this book provocative and useful for several reasons, despite its apparent lack of connection with design proper. Primarily, of course,



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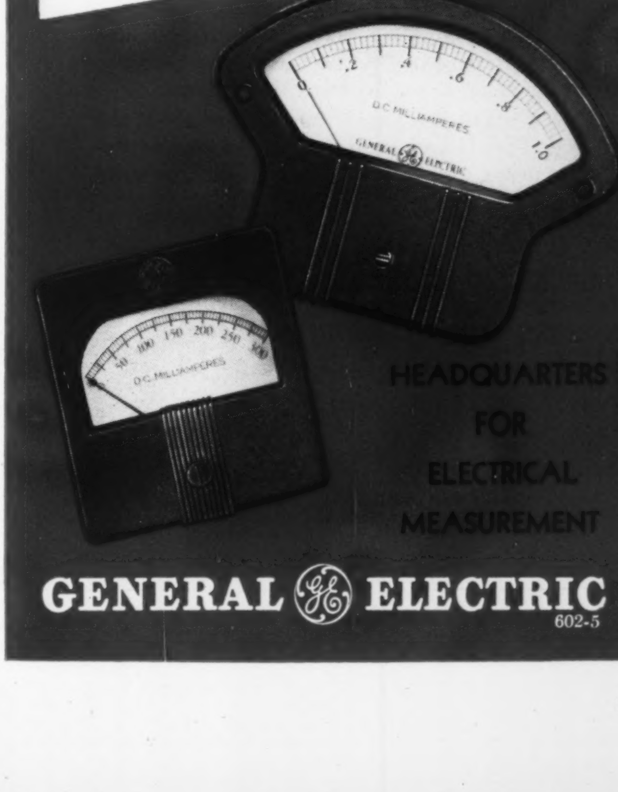

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GENERAL ELECTRIC

it is written for young technical graduates considering positions requiring sales of parts and machinery.

Since the design of a machine depends in large measure on the demands made on it by its ultimate users, a designer who gets into the field frequently finds his usefulness considerably enhanced. On such trips he will face many of the problems common to sales engineers and any information he can learn about selling will make his job that much easier. This volume is helpful in this connection.

For young engineers, the book presents in simple terms the principles of sales engineering, the importance of it in modern industry, and the opportunities open.

□ □ □

Mechanical Vibrations

By J. P. Den Hartog; published by McGraw-Hill Book Co. Inc. New York; 443 *pages,* 6 *by* 9 *inches, cloth bound; available through* MACHINE DESIGN *for* $5 *postpaid.*

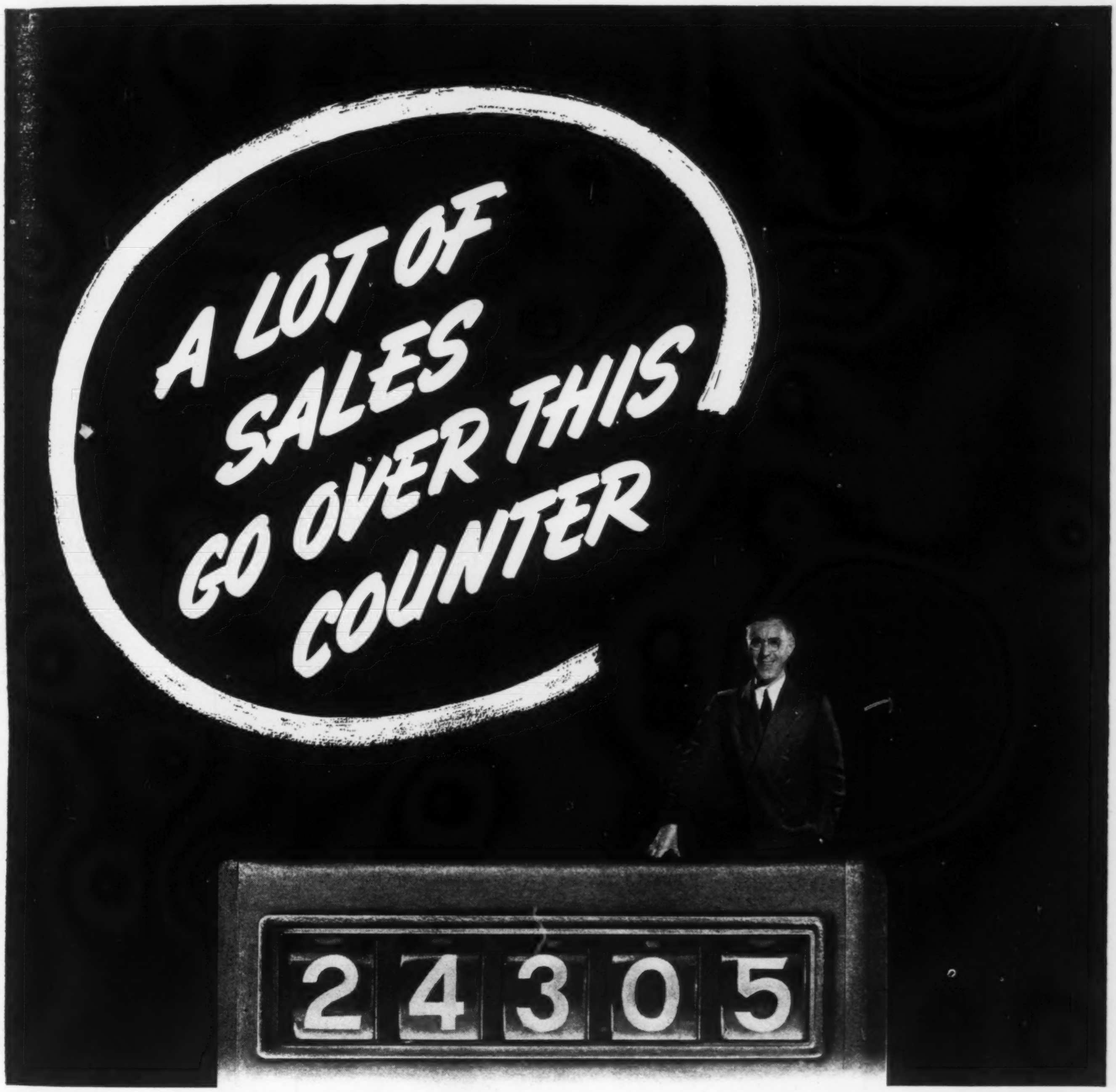
Much of the material contained in this book, now in its second edition, was originally given in lectures at the Westinghouse design school. When prepared for book form, however, the information was extended by including as illustrations a number of cases of vibration trouble actually occurring in machines. It has also been brought up to date by a discussion of some recent published material.

Since all important results are given in graph form and the topics discussed are only those which have proved of genuine practical interest, practicing designers as well as advanced students will find the book helpful. In addition a fairly complete set of references for additional information on topics discussed is included at the end.

The second edition includes coverage of the more important advances made in the subject during the last six years. Principal concern of this new matter is with electrical measuring instruments, contrifugal pendulum dampers, aircraft and ship propellers and automatic balancing machines.

Columbium-Iron Alloy Is Exceptional

COLUMBIUM, a relatively unfamiliar element with a minimum of commercial importance at present, produces an alloy of exceptional properties when added in small amounts to iron. For instance, samples containing three per cent columbium and the balance iron reveal exceptionally good rupture strength at 1100 degrees Fahr., a temperature not yet commercially used but being approached by modern high-temperature, high-pressure steam turbines. No carbon is contained. While special alloy steels are available for such duty, E. R. Parker of General Electric Co. has found they would be very expensive for turbines operating at temperatures over 1100 degrees. Mr. Parker found the columbium-iron alloy outstanding.



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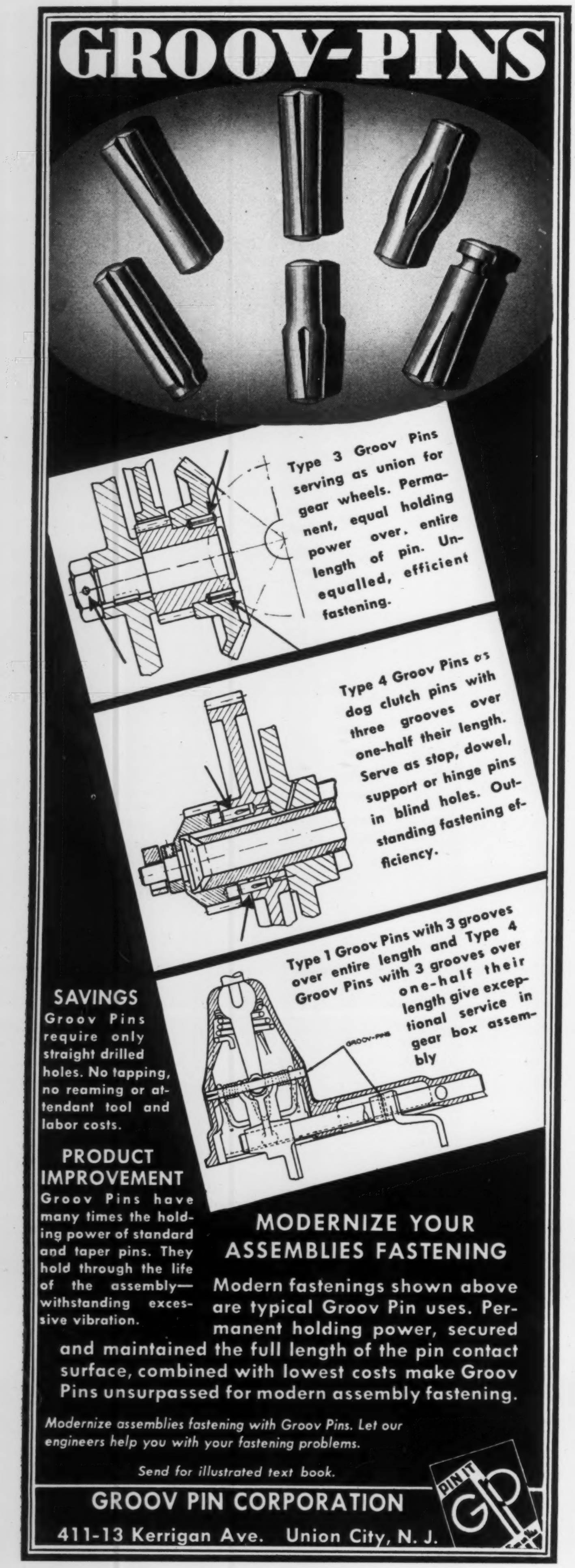
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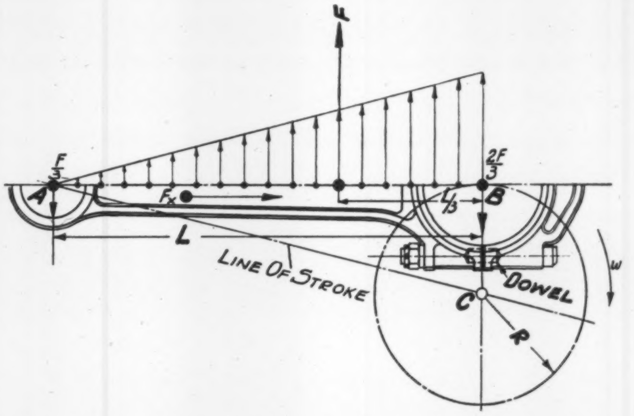
Professional Viewpoints

(Concluded from Page 68)

at which the crank and conn rod are at right with an acceleration of $\omega^2 R$ in feet per second per second, where R = crank pin radius in feet; ω = angular velocity of crank, supposed uniform.

The acceleration of the conn rod decreases uniformly along the rod to a zero value at the piston pin end, and since the section is uniform, the outward inertia forces, due to the mass of the rod, decrease in the same manner. Hence, referring to the drawing, acceleration at any point with a distance x in inches from A will be $x\,\omega^2 R/L$ feet per second per second, where L = Length of the conn rod.

In order to investigate the bending moment, it is first necessary to ascertain the reaction at A and B.



Since the inertia forces vary uniformly from a maximum at B to zero at A, F (their resultant) acts at a distance of $L/3$ from B and therefore reaction at

$$B = \frac{2F}{3}$$

$$A = \frac{F}{3} = \frac{W \times L \times \omega^2 \times R}{6g}$$

where W = Weight of conn rod in lb. per inch length. The maximum bending moment on conn rod equals $.002 W \omega^2 R L^2$

An approximate method is to substitute the inertia force with the centrifugal force created at B.

$$F = .000341\, W R N^2$$

where N = Revolutions per minute.

Loads that are present periodically but cannot be neglected and are created when the engine is running through a major critical are often of terrific impact. In such cases the vibration of the crankshaft develops a shaking force which is transmitted to conn rod, cap, and bolts, with sometimes disastrous results.

It was found mathematically and experimentally that all combined forces working under unfavorable conditions on the conn rod bolt can be three times larger than the inertia force of the reciprocating masses, depending on speed and size of the engine. In short, the bolt should be made as strong as the rod construction will allow. It can't be too strong.

—F. R. Umbach

Chicago Pneumatic Tool Co.

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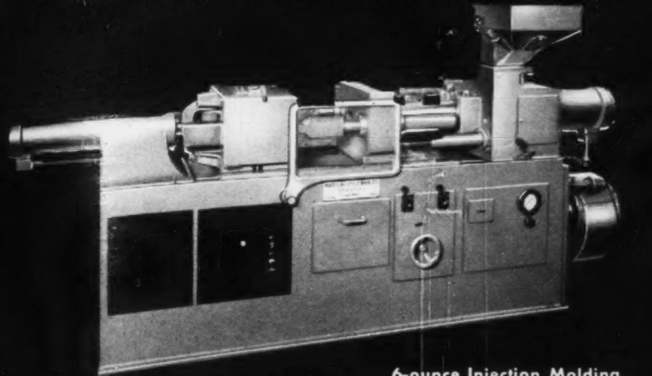
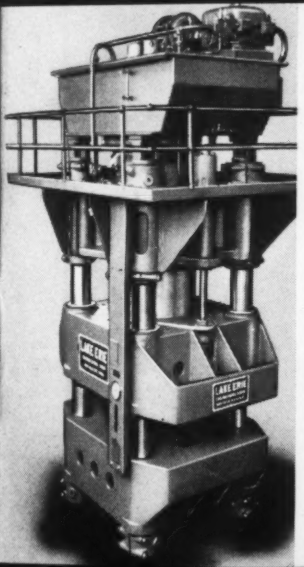
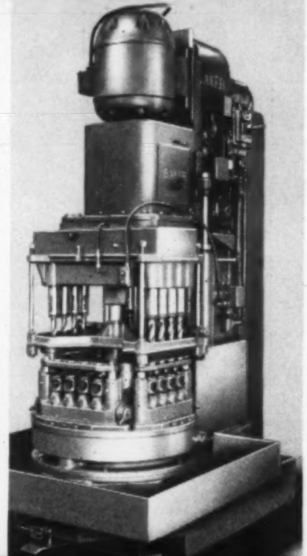
ties production to *Zooming Demand*



6-ounce Injection Molding Machine with Oilgear Type DP-3517 Pump for high cycle speed, variable working pressure, easy control and holding pressure without excessive heating or power loss. Watson Stillman Co., Roselle, N. J.

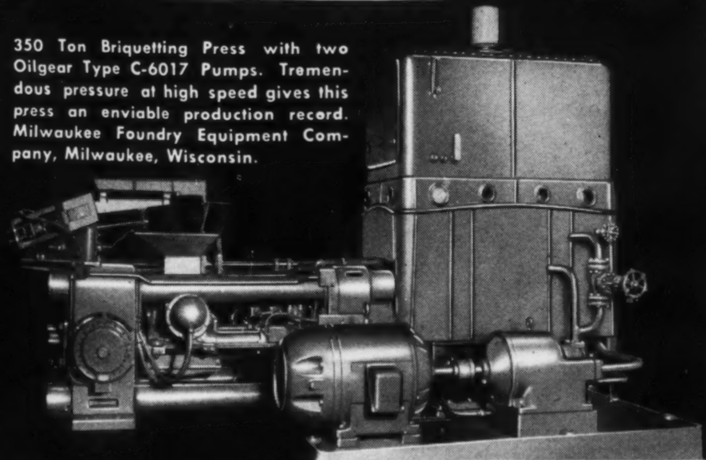


◀ 2500 Ton Forming Press equipped with Oilgear Type DX-10025 Pump... Remote control... 250″ per min. rapid traverse closing speed...9.5″ per minute high pressure pressing speed. Lake Erie Engineering Corporation, Buffalo, N.Y.

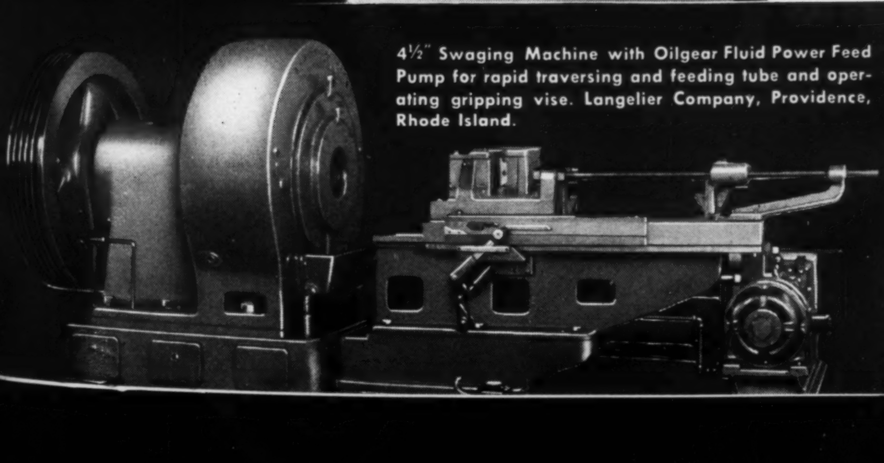


Multiple Spindle Vertical Drilling and Reaming Machine with Oilgear Fluid Power Feed Pump Unit. Feeding Pressures up to 18,500#. Drills as many as 33 pieces per hour. Baker Bros., Toledo, Ohio. ▶

350 Ton Briquetting Press with two Oilgear Type C-6017 Pumps. Tremendous pressure at high speed gives this press an enviable production record. Milwaukee Foundry Equipment Company, Milwaukee, Wisconsin.



4½″ Swaging Machine with Oilgear Fluid Power Feed Pump for rapid traversing and feeding tube and operating gripping vise. Langelier Company, Providence, Rhode Island.



To produce thousands instead of hundreds... and tons instead of pounds is the tremendous job industry is facing today. Factories must be reorganized . . . and in some cases completely re-tooled to keep up with today's urgent demands. The colossal task of re-tooling an entire nation of industry for "high gear" production lies in the hands of machine tool designers and manufacturers.

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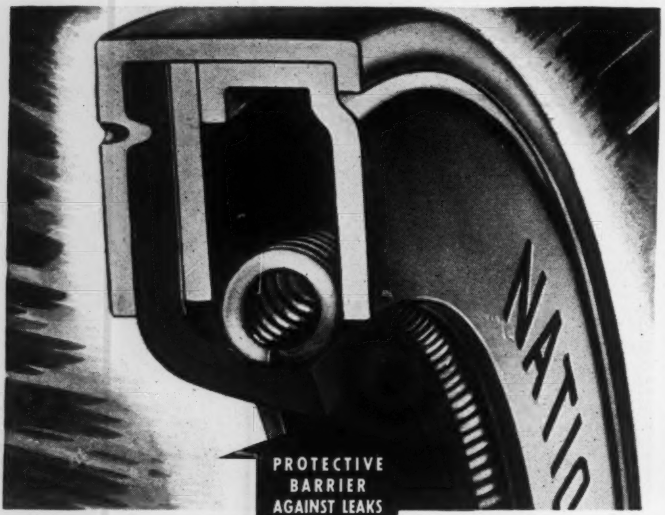

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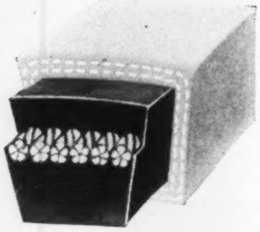
Oil & Fluid SEALS

New PARTS AND MATERIALS

Reducers Adapted to Small Motors

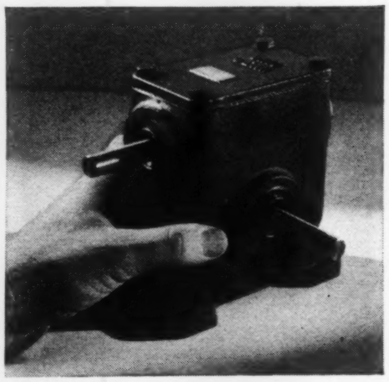
ESPECIALLY adaptable for use with fractional horsepower motors, a small speed reducer designated BHU is announced by the Ohio Gear Co., Cleveland. Its dimensions are 5⅜ by 3 inches, with a height of 5⅝ inches. It is offered in three assemblies with the output shaft projecting to the right, to the left, or to both sides. Six stock ratios are available between 10 to 1 and 48 to 1. A bronze worm wheel and a hardened ground worm operate on tapered roller bearings. Torque capacity is 150 inch-pounds.



Continuous temperatures to 150 degrees and peak temperatures of 200 degrees are resisted by belts

V-Belts Resist Oils, Acids

MADE entirely from synthetic gums, without rubber, oil-proof V-belts are announced by the Browning Mfg. Co. Inc., Maysville, Ky. Oil, gasoline, and many acids, alkalis and other chemicals have no deteriorating effect on these belts. They are resistant to continuous temperatures of 150 degrees Fahr. and to peak temperatures of 200 degrees. They are nonsparking.



Torque capacity of 150 inch-pounds makes small speed reducers especially suitable for use with fractional horsepower motors

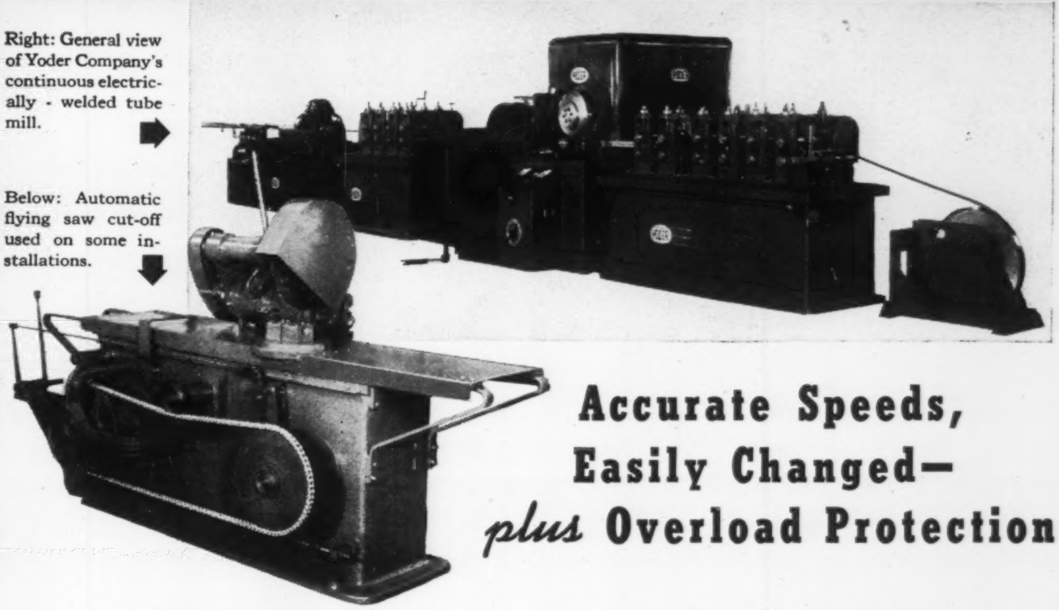
Fiber Rolls Have Zinc Spider

FIBER rolls of new construction which provides a tough rugged hub and spider of zinc alloy, cast into the body of the fiber, are announced by the Rockwood

How *Silverlink* ROLLER CHAIN Assists in ECONOMICAL DESIGN of Continuous Tube Mill

Right: General view of Yoder Company's continuous electrically - welded tube mill.

Below: Automatic flying saw cut-off used on some installations.



Accurate Speeds, Easily Changed— *plus* Overload Protection

A good example of how Silverlink roller chain assists in economical design and efficient machine operation is afforded by this continuous tube mill built by Yoder Co., Cleveland.

Units for forming, welding, straightening, sizing and cutting off, are driven through separate Silverlink roller chains. These chains assure positive, accurate synchronization of operations. Changes in shaft spacing and relative speeds can be had when desired, without extensive rebuilding of the machine. In addition to assuring dependable, non-slip power delivery on which the continuous, full production of the machine depends, these chains also provide a safety feature, since they will break under severe overload. They are much easier and cheaper to repair than machine parts.

Two triple, one double and two single width, Silverlink roller chains on the latest model, illustrated, replaced spur gears previously used.

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MATSURF
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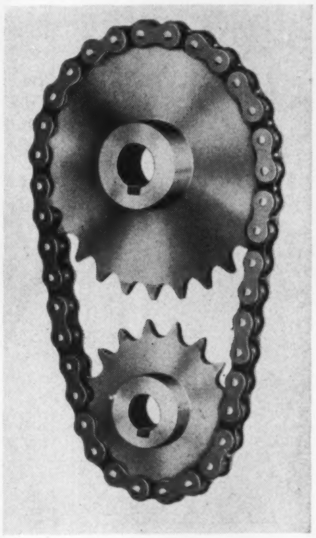
TRACING CLOTH
DULL ONE SIDE

Mfg. Co., Hamerstadt street, Indianapolis. Exceptional gripping power when used with rubber, fabric or leather belts is claimed for these fiber rolls. Several typical examples are shown in the illustration.

Small Chain Is Compact, Accurate

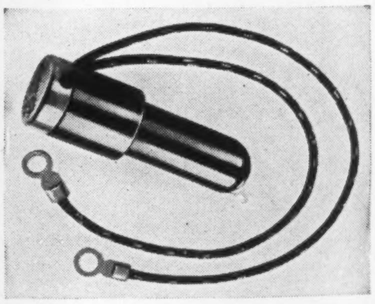
WEIGHING almost exactly half as much as the smallest power transmission chain previously made, No. 88 roller chain is announced by Diamond Chain & Mfg. Co., Indianapolis. Rollers are .197-inch in diameter by .125-inch wide, and pitch is .315-inch (8 millimeters). Weight is 1¾ ounces per foot. Made to same standards as larger chain, the 192 parts in each foot of No. 88 chain are assembled to a total length tolerance of only plus .0156-inch, minus .0001-inch. This new chain is equally suitable for dependable transmission at extremely high speeds and for maximum compactness without sacrifice of accuracy.



Small roller chain operates at extremely high speeds in applications where compactness and accuracy are required

Raise Mercury Switch Capacity

NEW internal construction characteristics of two mercury switches announced by Durakool Inc., department MD, Elkhart, Ind., enable them to carry substantially greater currents than the regular Durakool switches with the same dimensions. The new units are known as No. A-5M and No. A-10Z. Whereas the standard A-5 model is rated for 200 watts alternating current at an operating speed not over 20 times per minute, the same size A-5M has successfully withstood 750-000 operations on a 500-watt alternating current at an operating speed of five times per minute without stopping. It has also taken 50,000 operations on a 1000-watt direct current load at a rate of 25 times

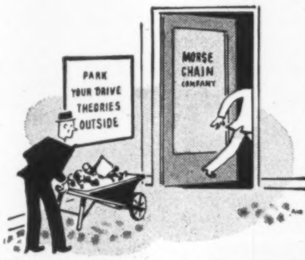


Substantially greater currents can be carried by new mercury switches with different internal design

Park your Drive Theories Outside

●

AND LEARN ABOUT MORSE ENGINEERED HIGH SPEED DRIVES


PARK YOUR DRIVE THEORIES OUTSIDE
MORSE CHAIN COMPANY

TRADITIONAL chain speed limits have been tossed out the window. Tossed out because some Morse engineers decided not to accept the old rules, and went ahead to find out what happened with drives which used larger sprockets having more teeth, and mile-a-minute chain speeds.

The results amazed even the engineers, pointed out a whole new series of facts on which to plan efficient, economical chain drives.

Centrifugal force, said the old beliefs, ruined the practicability of chain drives operating at speeds above 3,000 feet per minute. This seemed logical because of experience with other forms of drive using pulleys where additional tension is required at speeds above 3,000 feet per minute to offset the loss of "grip" due to centrifugal force.

"Teeth Not Tension" changes the whole picture.

Research in laboratory and field, carried on by Morse engineers for several years using larger sprockets with chain speeds zooming up to almost 8,000 feet a minute, has resulted in some new concepts of chain drive engineering. As sprocket sizes are increased, thus stepping up chain speed, the ability of the chain to transmit power increases tremendously, and unbelievably silent operation results. Since centrifugal forces do not cause loss of traction because of driving over teeth, they need not be considered as additional forces to the working load when within working limits of stress. Working loads can be increased at high chain velocity because of the tapered nature of load application, and maximum drive efficiency is realized when chain velocity reaches the point where centrifugal load equals working load.

Since, in a well-designed high speed drive, joint wear and consequent pitch elongation are practically eliminated, drives may operate on fixed centers. Even distribution of driving forces over nearly all teeth in contact makes sprocket wear slight, practically disappearing when teeth are heat treated.

With practically noiseless operation and simple lubrication made possible by the new Morse "wave" principle, bearing loads reach a new low with absence of drive tension and greatly reduced drive width.

The largest field for these drives is where ratios are from 1:1 to 4:1, and rotative speeds from 400 to 4,000. These drives have efficiencies up to 99.4% and insure noiseless operation, long and trouble-free life, greatly reduced bearing loads, and minimum space requirements.

The Morse chains and sprockets are carried in complete stocks in many cities throughout the country. Get in touch with the Morse man, and learn how Morse service continues to improve.

SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS KELPO CLUTCHES

MORSE *positive* DRIVES

MORSE CHAIN COMPANY ITHACA N. Y. DIVISION BORG-WARNER CORP.

WRIST WATCH
OR
LOCOMOTIVE—
It's Still a Machine!

●

Machines have become so interwoven with our economic structure that their identity often is lost. Whenever the word "machine" is mentioned a mental picture of a machine tool or other large unit often is formed. This impression is too limited in scope, the field of machines ranging from the tiniest wrist watch to the largest locomotive. MACHINE DESIGN likewise is all-inclusive, covering every size and type of machine manufactured.

Mechanical design knows no boundaries. Whether the unit is large or small, the procedure carried out in the evolution of an idea is essentially the same in every case. For that reason the designer of one type of machine often can find a solution to his particular problems in the accomplishments of design engineers in other fields.

MACHINE DESIGN serves as a clearing house for these ideas.

per minute. Performance of the A-10Z is equally impressive when compared to the standard A-10 switch. The A-5M has a very small required angular tilt for operation.

Coolant Pump Prevents Spurting

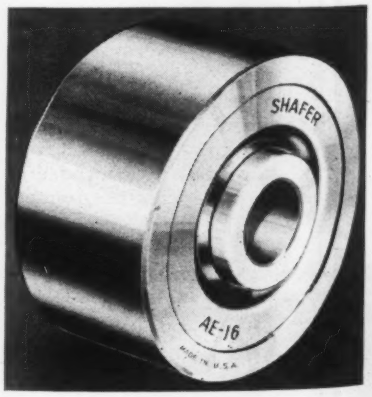
EXTREMELY compact with the discharge pipe rising vertically and clearing the motor, a Coolflo coolant pump is announced by Warren Steam Pump Co. Inc., Warren, Mass. The open type impeller is hard bronze, hydraulically balanced, and will circulate coolant containing dirt or abrasives with a minimum amount of wear and without clogging. Spurting and splashing is prevented because the flow of coolant may be decreased as much as desired without increase of the pressure.

WARREN
Coolflo
WARREN STEAM PUMP

Impeller of coolant pump will circulate dirt or abrasives with little wear

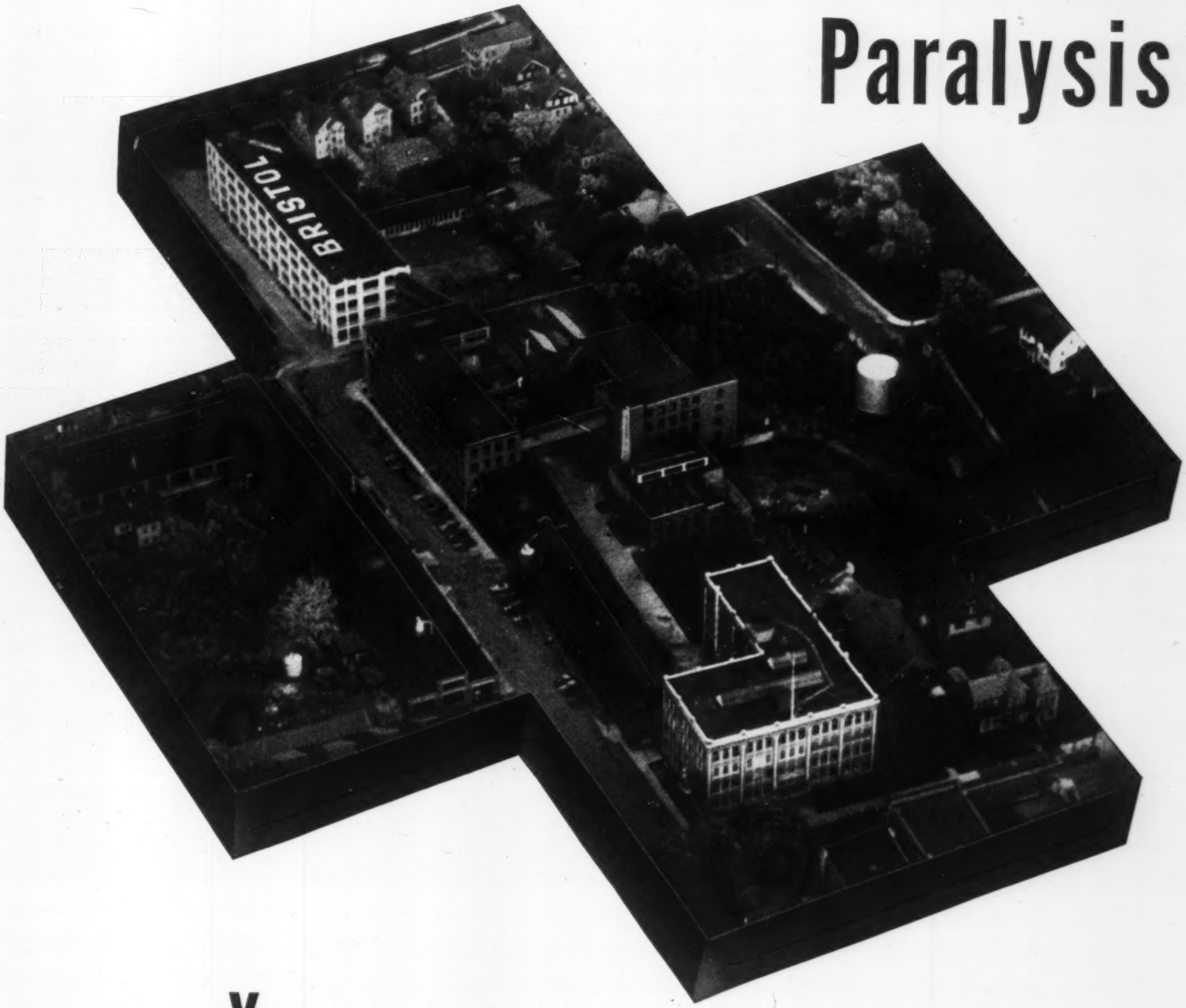
Bearings Are Self-Aligning

PROVIDING large load capacity and extreme self-aligning action in a compact bearing, the AE series of aircraft type, double row shielded roller bearings is announced by Shafer Bearing Corp., 35 East Wacker drive, Chicago. Rollers are placed at an angle between the curved races and will carry any type of loading



Inner race of shielded roller bearing is a true spherical element and concave rollers maintain full contact always

Here's FIRST AID for Production Paralysis!



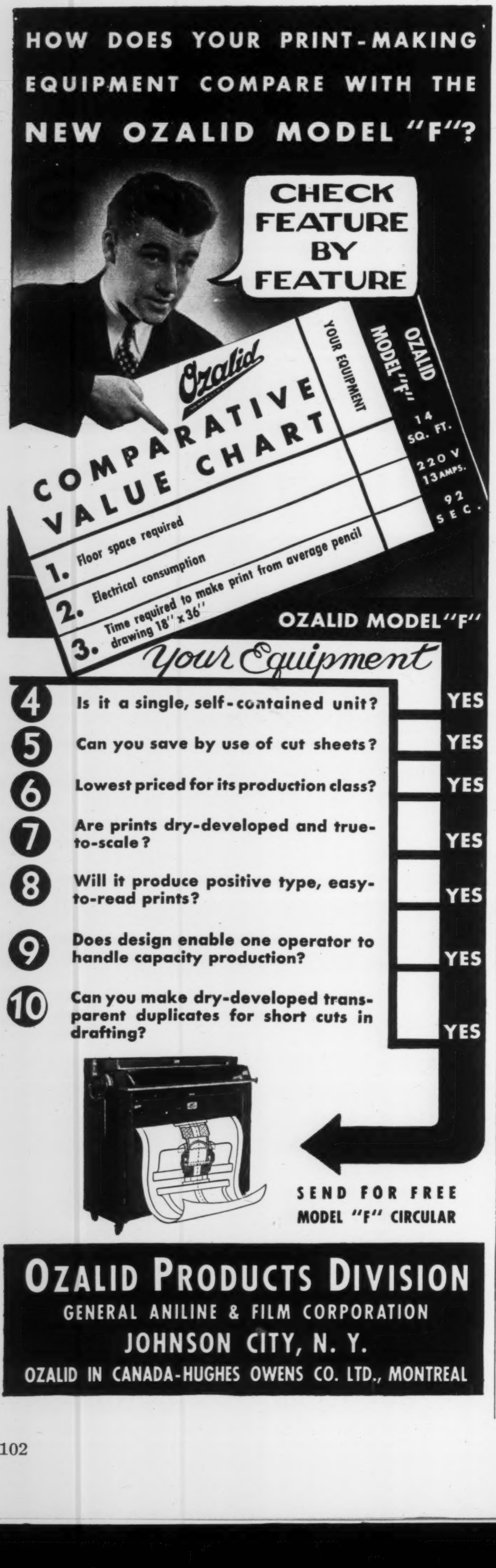
YOU can't afford to risk Production Paralysis by leaving your deliveries of springs to chance. You've got to **know** they'll be ready for your line when you want them.

Here at the Wallace Barnes Company, it is a matter of pride to deliver the goods. We can save you delivery worries on springs. May we try?

W-B
SPRINGS
SPRING STEEL
W-B

Wallace Barnes Company

Division of Associated Spring Corporation - BRISTOL, CONNECTICUT



HOW DOES YOUR PRINT-MAKING EQUIPMENT COMPARE WITH THE NEW OZALID MODEL "F"?

CHECK FEATURE BY FEATURE

Ozalid COMPARATIVE VALUE CHART

	OZALID MODEL "F"	YOUR EQUIPMENT
1. Floor space required	14 SQ. FT.	
2. Electrical consumption	220 V 13 AMPS.	
3. Time required to make print from average pencil drawing 18" x 36"	92 SEC.	

	Your Equipment	OZALID MODEL "F"
4 Is it a single, self-contained unit?		YES
5 Can you save by use of cut sheets?		YES
6 Lowest priced for its production class?		YES
7 Are prints dry-developed and true-to-scale?		YES
8 Will it produce positive type, easy-to-read prints?		YES
9 Does design enable one operator to handle capacity production?		YES
10 Can you make dry-developed transparent duplicates for short cuts in drafting?		YES

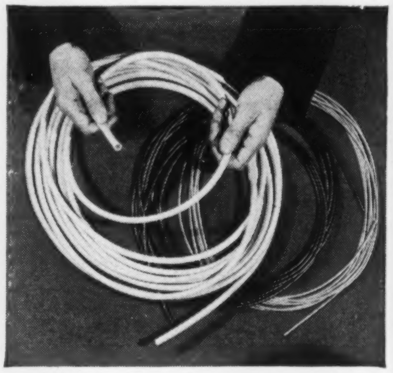
SEND FOR FREE MODEL "F" CIRCULAR

OZALID PRODUCTS DIVISION
GENERAL ANILINE & FILM CORPORATION
JOHNSON CITY, N. Y.
OZALID IN CANADA-HUGHES OWENS CO. LTD., MONTREAL

equally well and on the same full contact area under all conditions of alignment. The inner race is a true spherical element and hence is free to move in any direction without altering contact of the rollers. Seal washers are stainless steel and exposed surfaces are cadmium plated.

Plastic Tubing Resists Heat

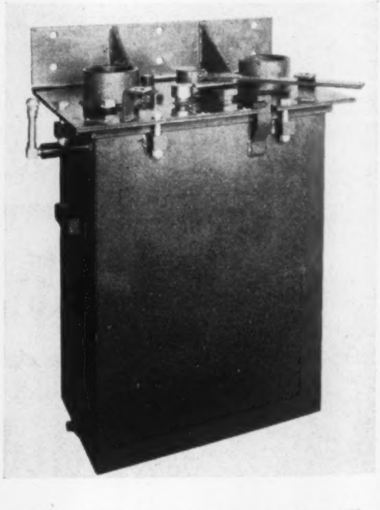
EXTRUDED plastic tubing with high heat resistance is announced by the Irvington Varnish & Insulator Co., 24 Argyle Terrace, Irvington, N. J. Known as Irv-O-Lite XTE-100, the new tubing is similar in many respects to XTE-30 tubing recently announced but has better resistance to sustained high temperatures. It maintains all its characteristics at a continuous temperature of 176 degrees Fahr. and is ideal for insulation purposes. It has a dielectric strength when dry of 750 volts per mil and of 400 volts per mil after 24 hours' soaking in water. It is flexible, smooth inside and out, has a tensile strength of 2000 pounds per square inch. Unaffected by petroleum solvents, it is not attacked by a 10 per cent solution of sulphuric acid and resists most acids and alkalis in concentrations up to 30 per cent by weight.



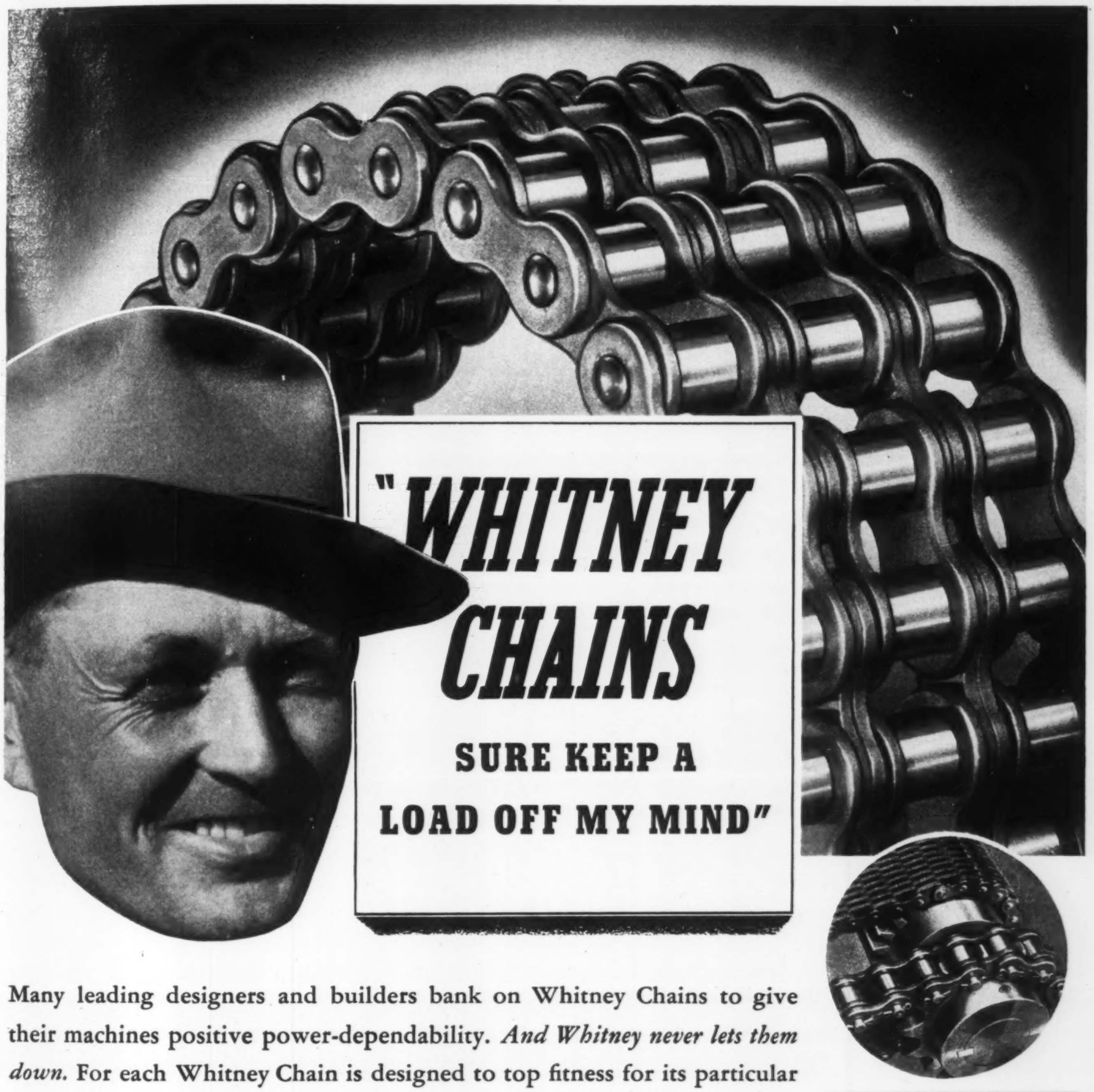
Flexible extruded plastic tubing resists acids and alkalis and has high heat resistance

Switch Is Oil-Immersed

AN OIL-IMMERSED disconnecting switch designated Type SF-1 has been developed by the General Electric Co., Schenectady. It is available as an enclosed triple-pole, single-throw, group-operating switch in the 5000-volt, 600-ampere rating. All terminals and connections are at least six inches under oil and double-break contacts with ample clearances are used. The operating lever which may be locked either open or closed gives positive indication of switch position. De-



All terminals and connections of disconnecting switch are at least six inches under oil



Many leading designers and builders bank on Whitney Chains to give their machines positive power-dependability. *And Whitney never lets them down.* For each Whitney Chain is designed to top fitness for its particular job . . . and is armored against the attacks of wear by special alloy steel, to provide the *extra toughness* needed to withstand today's conditions.

You can take this same load off *your* mind . . . for good . . . by specifying Whitney Chains for all power drives. Let a Whitney engineer help you on your problems in power transmission . . . show you how to keep machine-drive performance *always* up to customers' expectations. WRITE.

Whitney Products

Roller Chain & Sprockets, Silent Chain & Sprockets, Conveyor Chain & Sprockets, Roller Chain Flexible Couplings, Automatic Load Limiting Sprockets, Automatic Drive Tensioners, Woodruff Type Machine Keys and Cutters.

The Whitney Chain & Mfg. Company, Hartford, Conn.

WHITNEY CHAINS

Is your plant PREPARED for MAXIMUM PRODUCTION?

• Are you allowing fixed machine speeds to bottleneck your production? Provide the right speed at the right time with

LEWELLEN
Variable Speed Control

and conquer today's great production challenge!

Infinitely variable speed control is a "must" for the high speed production demands of the day. Install a Lewellen Variable Speed Transmission (left illustration) or Motor Pulley (right illustration) in the drive of each production machine. Then, watch production increase! The quality of finished units is improved—rejections are reduced to a minimum.

Our engineers are constantly working with companies in order to solve their speed control problems. This is our specialty. It has been for more than 40 years. Why not call a Lewellen representative today or write us direct?

EXPECT REMARKABLE RESULTS! With the proper size Lewellen Pulley you can drive a machine at infinitely variable speeds; connect directly between the motor and the machine; operate the driven shaft at desired speeds. And, think what a saving it means to operate your production machines at the CORRECT SPEED! There is a Lewellen Pulley for your motor horsepower and speed, for all ratings from fractional to 7½ h.p. The speed range is 3 to 1 for all pulley sizes. (One size has a speed range of 2¾ to 1.) **Call your Lewellen representative or write today for complete information.**

LEWELLEN MANUFACTURING CO., COLUMBUS, INDIANA

Lewellen knows speed control

sign of the operating shaft assembly is such that it will withstand more torque than can be applied on the operating lever by one man. An interlock on the operating lever prevents opening of the switch under short circuit or load.

Timer Offers Twelve Scales

ENCLOSED in a specially built, dust-tight and splash-proof cast aluminum housing arranged for conduit connection, model D2 interval timer is announced by the R. W. Cramer Co. Inc., Centerbrook, Conn. It is provided with a full vision window and external setting knob. Twelve different time scales are available, ranging from one revolution in 15 seconds to one revolution in 24 hours. A slight inward pressure on the sturdy knob assembly engages a clutch for setting the timer. When released, a spring and gasket prevent entrance of moisture around the control shaft. Housing is finished in black crackle.

Control is accomplished through specially designed snap-action relay in universal interval electronic timer

0
30 MIN SCALE
5
30
25
10

Shim Stock Marked in Lengths

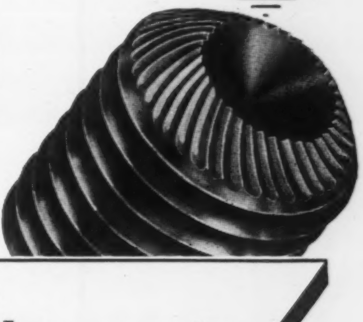
THIN shim stock supplied in slotted carbons by Laminated Shim Co. Inc., Glenbrook, Conn., is now furnished plainly marked in inches on its edge, from zero to 100 inches, with half-inch subdivisions. Waste is avoided and storage is facilitated.

Waste is avoided with thin shim stock which has lengths plainly marked on edges

Program Clocks On Market

TWO synchronous program clocks for operating time signals are being made by Zenith Electric Co., 845 South Wabash avenue, Chicago. Type P-512 will operate a signal at any five-minute period and type PD-124 at any one-minute period. Driven by heavy duty synchronous motors, these clocks have

KNURLED



Unique "UNBRAKO" refinements that help you to do a better job

. . . A BETTER JOB with "Unbrako" Cap Screws because the cold-forged knurled heads gear right to the fingers and prevent annoying finger slip. They turn faster and farther before applying wrench or pliers, hence speed up assembly. Finished appearance is neater on any product.

. . . A BETTER JOB with "Unbrako" Self-Locking Hollow Set Screws because their knurled points insure a vibration-defying grip. Set them up with no more than average pressure and they *hold tight!* Save maintenance costs . . . prevent costly trouble. Yet "Unbrako" Self-Lockers are easily applied or removed and can be used over and over again.

Get complete information now. Ask your distributor, or write—

STANDARD PRESSED STEEL CO.
JENKINTOWN, PENNA. BOX 102
BRANCHES
BOSTON • DETROIT • INDIANAPOLIS • CHICAGO • ST. LOUIS • SAN FRANCISCO

Reg. U. S. Pat. Office
UNBRAKO
Screw Products

THIS BALDOR
YEAR-AHEAD
MOTOR

BALDOR
ELECTRIC

will add
EXTRA SALES FEATURES
to your 1941 product
at no extra cost . . . .

STREAMCOOLED. Provides a ball bearing totally enclosed protected motor with a non-clogging cooling system.

GLASS INSULATED. Permits more horse power in the same space and longer life under abusive service.

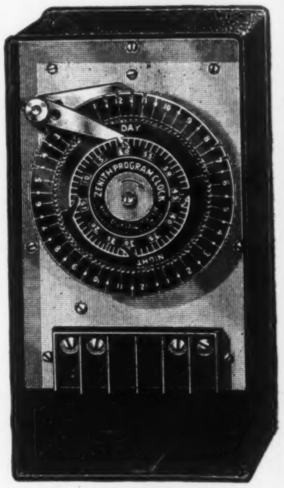
NO EXTRA COST. Baldor streamcooled motors, in either standard insulation or glass insulation at ordinary open motor prices.

Many other features explained in BALDOR Bulletin No. 202. Ask for it.

BALDOR ELECTRIC COMPANY, ST. LOUIS
Representatives in Principal Cities

BALDOR
BETTER MOTORS

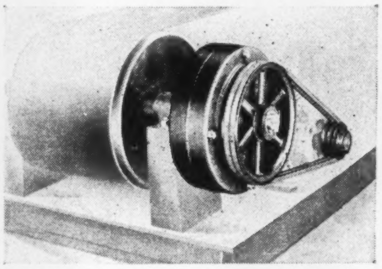
large legible 24-hour dials and a one-hour dial cam. Pointers connected to a contact arm ride the dials and permit the contact arm to fall only when preset time is reached. Units are compact and enclosed in dustproof cases.



Pointers connected to contact arm in synchronous program clocks ride dials and permit arm to fall only when preset time is reached

Announce Speed Reduction Drive

TWO major elements comprise a speed reduction drive announced by The American Pulley Co., Philadelphia. A helical gear reduction unit mounts directly on the shaft of the driven machine and a standard belt drive is between the motor and the input shaft of the reduction unit. The unit itself has a fixed ratio of 13 to 1, different ratios being accomplished by the primary belt drive. Five models cover all applications from ½ to 30-horsepower.



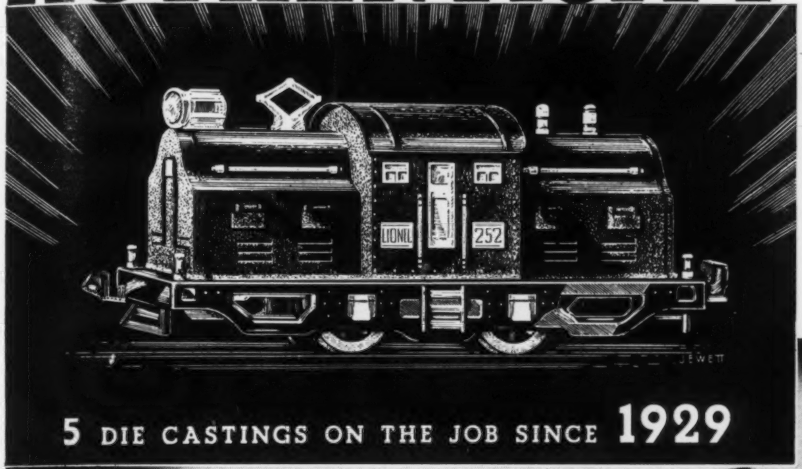
Drive comprises gear reduction unit mounted on driven shaft and a standard belt drive on reduction unit

Pillow Blocks Applied Easily

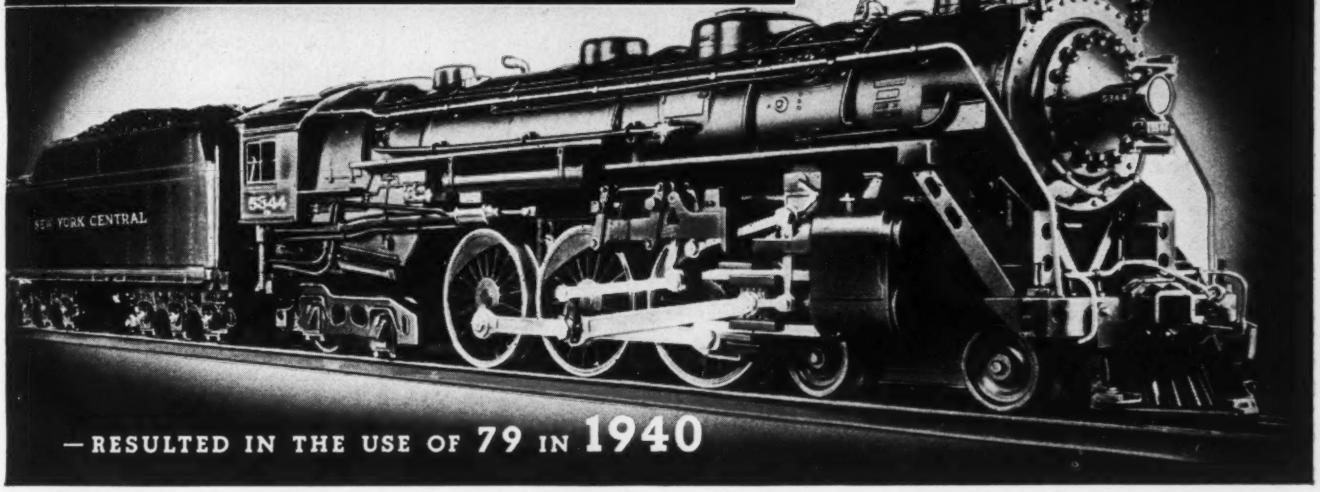
A SERIES of ball bearing pillow blocks and other transmission units incorporating "Mechani-Seal" ball bearings is announced by the Fafnir Bearing Co., New Britain, Conn. Ease of application is assured by the wide inner ring design, with self-locking collar. The units are locked to the shaft with a finger-twist, and no machining, shaft shoulders or adapters are necessary. Interchangeable with the

Ball bearing transmission units with integral seal are interchangeable with earlier separately sealed units

AUTHENTICITY —DIE CASTINGS PROVIDE REALISM IN MINIATURES



5 DIE CASTINGS ON THE JOB SINCE 1929



—RESULTED IN THE USE OF 79 IN 1940

Miniature trains are built for youngsters—and American youngsters are tough customers. Their scaled-to-size toys must not only resist abuse, but they must be authentic reproductions of the parent models. This demand for realism is one of the many reasons for the constantly increasing use of ZINC Alloy Die Castings in the toy industry.

When 5 ZINC Alloy Die Castings were utilized in the construction of a toy locomotive produced in 1929, it was in the nature of an experiment. But the 79 die castings in the 1940 Hudson type locomotive and tender—produced by the same manufacturer—are far from an experiment. This selection of material is based on 11 years of experience, during which ZINC Alloy Die Castings offered the maximum in detail and strength—at a minimum production cost.

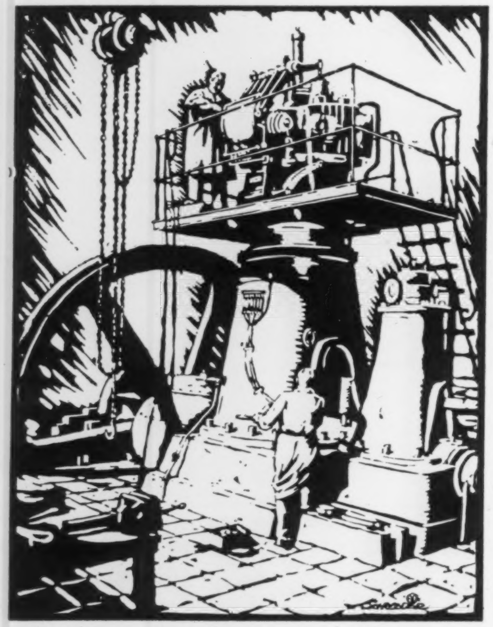
Do these qualities suggest possible improvements in your products through the use of ZINC Alloy Die Castings? If you are not thoroughly informed on the physical and economic advantages offered with this metal and production method, we suggest that you consult a commercial die caster—or write to The New Jersey Zinc Company, 160 Front Street, New York City.

This advertisement is the eighth of a series. Copies of those preceding gladly mailed on request.

ZINC ALLOY DIE CASTINGS

The Research was done, the Alloys were developed, and most Die Castings are made with

HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC



INVENTIVE GENIUS DESERVES PROTECTION

. . . and the Government offers this protection.

What is patentable? . . . What is infringement? . . . What primary steps are necessary for protection? . . . How are disclosures made? . . . and the thousand and one other questions that confront the layman, the engineer, the business man . . . all are answered in this single, conveniently indexed volume.

"Inventions and Their Protection"

Hundreds of copies of this book are already in daily use in designers' offices . . . they are the guide-books for foresighted engineers who want to protect themselves and their employers. This book may well pay for itself in answering any question that arises.

JUDGE FOR YOURSELF . . . ORDER A COPY FOR FREE EXAMINATION

You can judge the worth of "Inventions and Their Protection" for yourself, without obligation. Order a copy today on ten days approval. If, after ten days, you are not satisfied, return it in good condition and your bill will be canceled. If you wish to send payment with your order, postage will be prepaid.

"INVENTIONS AND THEIR PROTECTION": by George V. Woodling; 316 pages; fully illustrated; bound in blue cloth; $5 postpaid (plus 15c to cover compulsory state sales tax for copies to be delivered in Ohio).

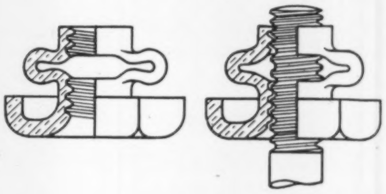
THE PENTON PUBLISHING CO.
Book Department
1213 W. Third Street Cleveland, Ohio

INVENTIONS AND THEIR PROTECTION
WOODLING
MACHINE DESIGN SERIES
PENTON

separately sealed Fafnir models which preceded them, the new units are available in Types LAK (pillow block), LCJ (flange cartridge), and LC (cylindrical cartridge). The "Mechani-Seal" bearing employs close tolerances between the sealing members for its efficiency.

Wing-Nut Line Is Developed

A VIBRATION-RESISTING, exceptionally strong self-locking wing-nut is announced by Scovill Mfg. Co., Waterbury, Conn. When applied, the spring member of the nut expands to locking position, providing a constant tension. In addition this nut is 10 to 15 per cent lighter and is all metal, one piece. Present sizes run from No. 6 to ¼-inch.



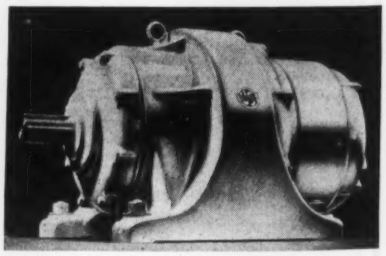
Spring member of one-piece nut expands to locking position when applied and provides constant tension

Controls Temperature, Humidity

A SELECTOR control for maintaining constant temperature and humidification and dehumidification control in process air conditioning is announced by the General Electric Co., Schenectady. When used with a three-wire, "floating" type thermostat or humidistat, the unit provides close control of temperature or humidity under widely varying conditions.

Gearmotors Have Pyramidal Pedestal

DOUBLE and triple reduction gearmotors up to 30-horsepower at 91 revolutions per minute have been added to the line made by U. S. Electrical Motors Inc., Los Angeles. The larger unit incorporates the pyramidal gear pedestal design which provides ample support to withstand the extra torsional strains and load shocks of geared power. All castings used are normalized, thereby assuring permanent alignment of bearings and gears. Internal stresses are removed. Both primary and secondary gears dip in a large oil reservoir in the base.



Pyramidal gear pedestal in gearmotors provides ample support to withstand extra torsional strains

Prevents Crane Hook Overtravel

OPERATING by means of a counterweighted lever and a suspended reset weight, a new type main circuit crane safety limit stop is announced by Cutler-Hammer Inc., Milwaukee. It prevents overtravel of the crane hook when hoisting. As the hook approaches its limit of travel the reset weight is raised, allowing the counterweight to trip the switch. When the limit

MAKING HISTORY

. . . the ONLY motors with rotor windings centrifugally cast of COPPER!

● Fairbanks-Morse Motors with centrifugally cast rotor windings of *solid copper* are making history. That's natural. Every industry that uses motors has long needed the thermal and electrical characteristics that only motors with one-piece rotor windings of solid copper can provide. Every motor manufacturer has tried for years to build such a rotor. Many made centrifugally cast windings of OTHER metals—but NOT of *copper*.

Then Fairbanks-Morse did it. It took time and money. But the result is worth the cost. Fairbanks-Morse now gives industry a better motor capable of standing up under certain conditions of *severe* service that no other motor could long endure. This motor reduces operating cost. It provides more years of trouble-free operation. It is worth investigating if you use motors. Write Fairbanks, Morse & Co., Dept. 53, 600 So. Michigan Ave., Chicago, Illinois. Branches and service stations throughout the United States and Canada.

7854-EA40.158

Copperspun

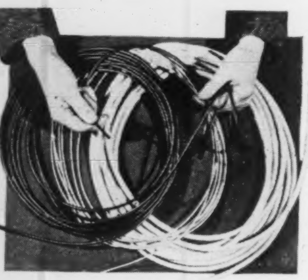
FAIRBANKS-MORSE MOTORS

DIESEL ENGINES ELECTRICAL MACHINERY RAILROAD EQUIPMENT WASHERS-IRONERS STOKERS
PUMPS FAIRBANKS SCALES WATER SYSTEMS FARM EQUIPMENT AIR CONDITIONERS

A NEW AND BETTER INSULATION FOR WIRING

XTE-30
XTE-100

Extruded Plastic Tubing in Continuous Lengths for Electrical Insulation in Many Industries.



•

AGAIN IRVINGTON has pioneered in the development and manufacture of an American-made extruded plastic tubing for insulation. High dielectric strength, high mechanical strength, and hitherto unattainable resistance to tearing, abrasion, heat, fire, and solvents are its outstanding advantages in use. Advantages for the manufacturer include extreme flexibility, inside and outside smoothness, thin walls, resistance to soldering temperatures, and availability in continuous lengths. Yet this remarkable new product is low in cost.

XTE-100 is used where highest temperatures are encountered, XTE-30 for all other applications.

**Condensed Table of Properties of Irv-o-lite Extruded Tubing for Electrical Insulation*

		XTE-30	XTE-100
FLEXIBILITY	Excellent at all temperatures down to	-4° F.	32° F.
TENSILE STRENGTH	of No. 8 tubing, in lbs. per sq. in.	2000	2000
HEAT RESISTANCE	will not crack when bent over A.S.T.M. specification mandrel, after heating at 220° F. for	120 hrs.	more than 240 hrs.
FIRE RESISTANCE	A.S.T.M. specification	won't support combustion	won't support combustion
OIL RESISTANCE	heated in transformer oil at 220° F for 48 hours	slight stiffening	slight stiffening
DIELECTRIC STRENGTH	volts per mil up to .022" wet volts per mil up to .022" dry	350 750	400 750
SOLVENT RESISTANCE	both resistant to following	all petroleum solvents—benzol—toluol—denatured alcohol—acid (30% conc.)—alkalies (30% conc.)	

*For complete data, including tests, sizes, lengths and colors regularly manufactured, uses, samples, and prices, write today for Bulletin, XTE-30 and XTE-100.

Irv-o-lite XTE-30
XTE-100

IRVINGTON INSULATION

IRVINGTON VARNISH & INSULATOR CO.
IRVINGTON, NEW JERSEY, U. S. A.

PLANTS AT IRVINGTON, N. J. and HAMILTON, CANADA
Representatives in 20 Principal Cities

stop is in the tripped position a bypass circuit is established which permits backing out of the limit at slow speed. Rating is 100-horsepower at 230-volts direct current.

As crane hook approaches end of travel, reset weight is raised and counterweight trips crane limit stop

Motor Supplies Three Torques

BY MEANS of a special arrangement of stator windings, a new three-phase motor announced by General Electric Co., Schenectady, can be readily reconnected at the terminal board for compressor drive service on any one of three voltages. The motor is ordinarily supplied for 199, 208 and 220-volt operation and will provide three different torques, depending on how its leads are connected. Regardless of the voltage employed, however, all of the stator winding is used all of the time and thus motor characteristics are maintained under all operating circumstances. The new motor incorporates the new Valv-Amp rotor and is available in sizes up to 200-horsepower.

Control Levels Electronically

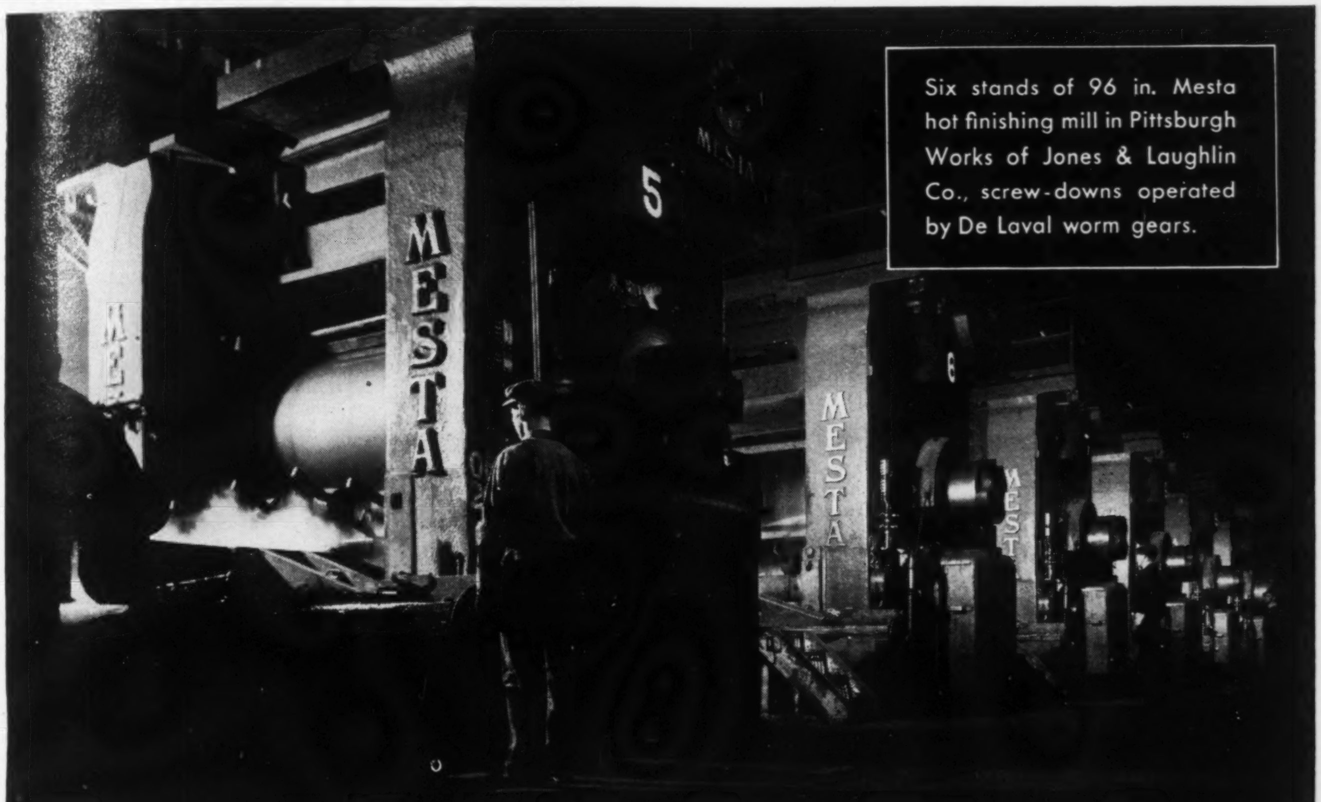
FOR level control of both conductive and nonconductive fluids and powders, Type P30 electronic level control is announced by Photoswitch Inc., Cambridge, Mass. Equipment is available to meet all specifications including single level control, on and off control at two levels, boiler feedwater control and tank condensate signals. Type P30 is recommended for use with all conductive fluids and many insulators.

PHOTOSWITCH
P

Conductive and nonconductive fluids and powders are kept at proper levels by photoelectric control

Thermoswitches Announced

TWO thermoswitches, the air and immersion types, are announced by Fenwal Inc., Ashland, Mass. The air thermoswitch illustrated is basically a cartridge type to which has been attached a junction box, providing facility for attaching BX cable or conduit to a terminal block within the protective cover. The immersion model also permits attaching conduit within



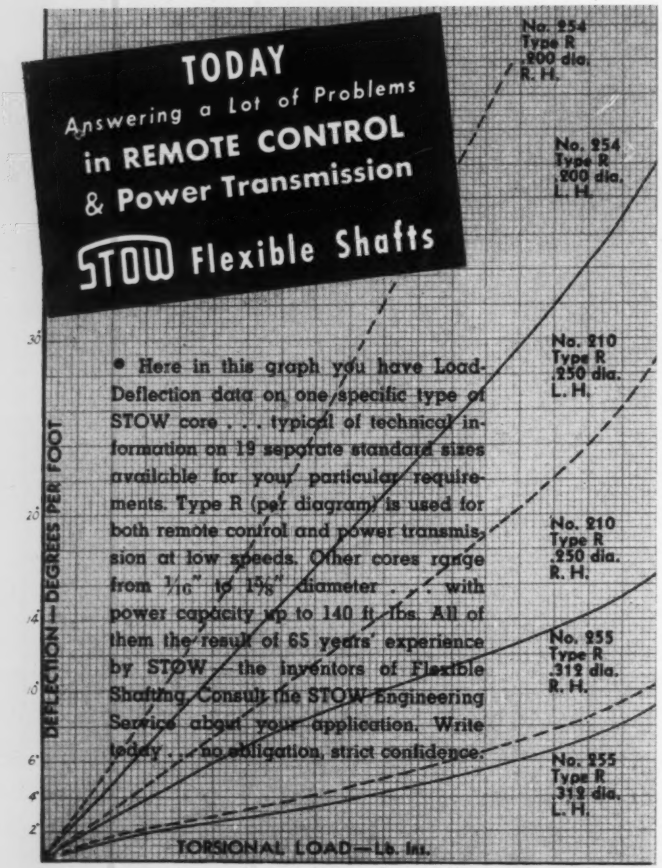
Six stands of 96 in. Mesta hot finishing mill in Pittsburgh Works of Jones & Laughlin Co., screw-downs operated by De Laval worm gears.

For smooth application of great force

use DE LAVAL WORM GEARS

1114

DE LAVAL WORM GEAR DIVISION
of the De Laval Steam Turbine Co., Trenton, N. J.



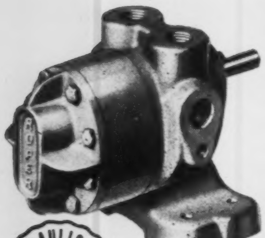
TODAY
Answering a Lot of Problems
in REMOTE CONTROL
& Power Transmission
STOW Flexible Shafts

• Here in this graph you have Load-Deflection data on one specific type of STOW core . . . typical of technical information on 19 separate standard sizes available for your particular requirements. Type R (per diagram) is used for both remote control and power transmission at low speeds. Other cores range from 1/16" to 1⅜" diameter . . . with power capacity up to 140 ft.-lbs. All of them the result of 65 years' experience by STOW—the inventors of Flexible Shafting. Consult the STOW Engineering Service about your application. Write today . . . no obligation, strict confidence.

STOW MANUFACTURING COMPANY, INC.
11 SHEAR STREET BINGHAMTON N. Y.

WHEN YOU CHECK

COST FIGURES YOU'LL FIND
ROPER ROTARY PUMPS
OPERATE FOR LESS



Roper Pumps with only two moving parts have equal size pumping gears, bronze bearings which act as wear plates, hydraulic balance with internal pressure equalized at all points, quiet spiral tooth gears with high volumetric and mechanical efficiency and a chatterproof and leakproof built-in relief valve which is positive protection against excessive pressure. A study of our Catalog . . . 7548 different Roper Pumps to select from . . . will enable you to specify a combination that results in practically a custom-built pump.

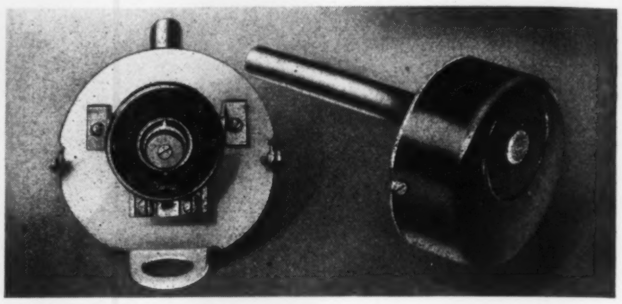
HYDRAULICALLY BALANCED

Write for Catalog 932 or see our catalog in Sweet's

GEO. D. ROPER CORP., ROCKFORD, ILLINOIS

ROPER *Rotary* PUMPS
DEPENDABLE SINCE 1857

a cover and is an improvement of the regular hex head type. These thermoswitches are classified as regular when contacts open on increase in temperature, and as inverse when the contacts open on a decrease in temperature.



Facility is provided in thermoswitches for attaching conduit within protective cover

Engineering Dept. Equipment

Instrument Measures Vibration

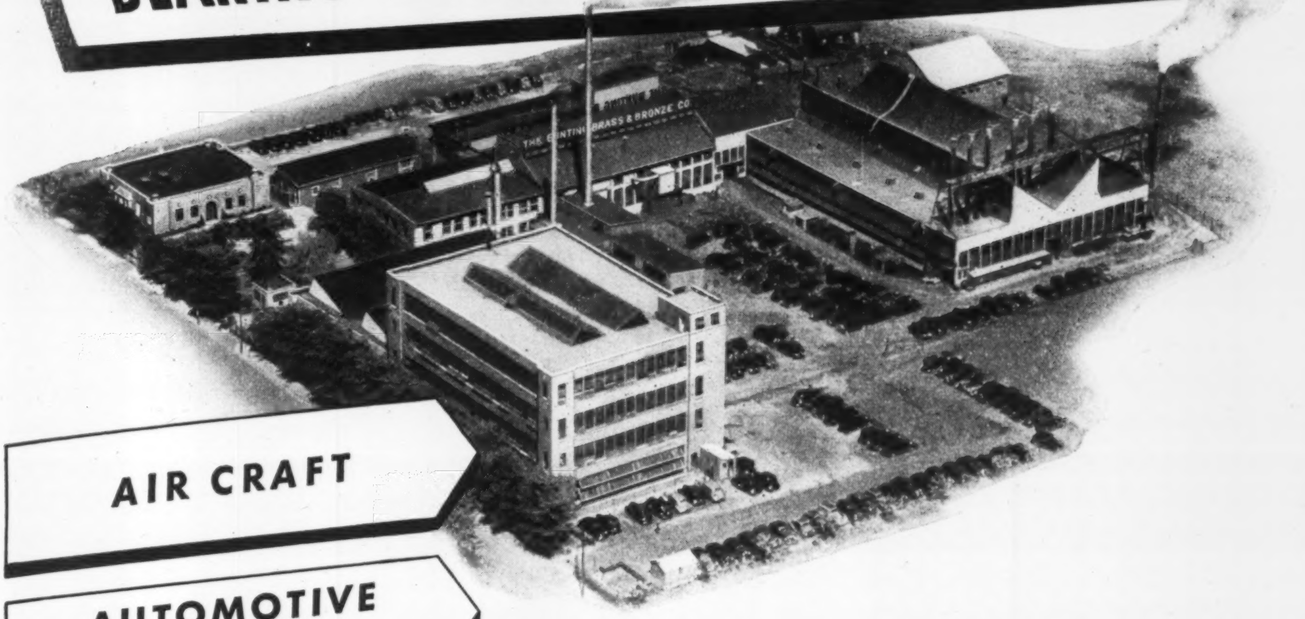
A VIBRATION frequency meter, weighing only eight ounces and designed to aid in discovering both the causes and cures of machine vibrations, is announced by Westinghouse Electric & Mfg. Co., East Pittsburgh. No larger than a slide rule, the instrument can indicate what frequencies between 500 and 20,000 cycles per minute are present in a vibrating body. It is built around the vibrating reed principle and consists of a thin spring steel vibrator clamped at one end between a set of steel rollers. A knurled knob connected to the rollers permits their rotation and moves the steel reed in and out, changing its frequency. A sliding pointer on the back end of the reed indicates the vibrating frequency which is read off the calibrated scale on the frame.

Vibration frequency meter is built on principle of vibrating reed

Tracing Cloth Conditioned

FOR preparing the surface of tracing cloth prior to inking, the IXL tracing cloth conditioner is announced by David White Co. Inc., 315 West Court street, Milwaukee. The IXL conditioner is made from a special treated extra fine metal wool from which all oil and impurities have been removed. The small metal brush furnished with the outfit is used to clean the conditioner.

BEARINGS FOR EVERY APPLICATION
BEARING SERVICE FOR EVERYBODY...



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FACILITIES and experience of this organization cover every phase of research, design, and production of cast bronze bearings and parts. Many leading engineers and manufacturers find the specialized departments of this company of definite value in the making of specifications for bearings and in the production of the finished items. It costs you nothing to find out if and how we can serve you . . . The Bunting Brass & Bronze Company, Toledo, Ohio. Warehouses in All Principal Cities.

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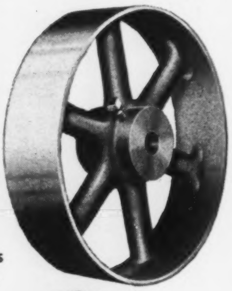

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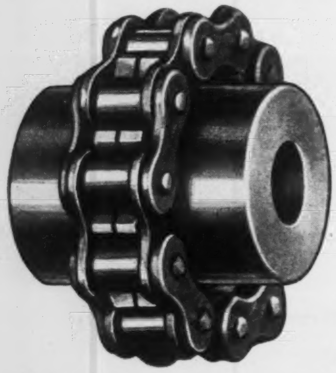
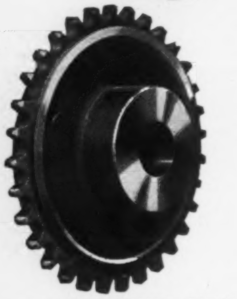
SPROCKETS for Roller Chains





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A Speed Reducer for Every Application

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SWITCH
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THE NATIONAL ACME CO., Cleveland, Ohio

Meetings and Expositions

Dec. 2-4—

American Institute of Chemical Engineers. Annual meeting to be held at New Orleans. Stephen L. Tyler, 50 East Forty-first street, New York, is secretary.

Dec. 2-6—

American Society of Mechanical Engineers. Annual meeting to be held at Hotel Astor, New York. The banquet will be held Dec. 4. C. E. Davies, 29 West Thirty-ninth street, New York, is secretary.

Dec. 2-6—

American Society of Agricultural Engineers. Semiannual meeting to be held at Stevens Hotel, Chicago. Raymond Olney, St. Joseph, Mich., is secretary.

Dec. 2-7—

National Power Show. Fourteenth exposition to be held at Grand Central Palace, New York. Information may be obtained from the 14th National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York.

Dec. 4-6—

Institute of Cooking and Heating Appliance Manufacturers. Annual meeting and exposition to be held at Netherlands Plaza Hotel, Cincinnati. Samuel Dunckel, Shoreham Hotel, Washington, is managing director.

Dec. 5—

Aeronautical Chamber of Commerce of America Inc. Annual meeting to be held in New York. Oliver L. Parks, 729 Fifteenth street, N. W., Washington, is secretary.

Dec. 6-7—

National Standard Parts association. Annual meeting and exhibition to be held at Sherman hotel, Chicago. C. D. McKim, 1420 United Arts building, Detroit, is secretary.

Dec. 9-11—

National Warm Air Heating and Air Conditioning association. Semiannual meeting to be held at Hotel Statler, Detroit. George Boeddener, 5 East Long St., Columbus, O., is secretary.

Dec. 10-11—

Mississippi Valley Farm Equipment association. Annual meeting to be held at DeSoto hotel, St. Louis. W. V. Jeans, 206 DeSoto Hotel, St. Louis, is secretary.

Dec. 12—

Grinding Wheel Manufacturers association. Quarterly meeting to be held at Claridge hotel, Atlantic City. Harry B. Lindsay, 27 Elm street, Worcester, Mass., is secretary.

Jan. 6-10—

Society of Automotive Engineers. Annual meeting and exhibit to be held at Book-Cadillac hotel, Detroit. John A. C. Warner, 29 West Thirty-ninth street, New York, is secretary and general manager.

Jan. 8—

American Washer and Ironer Manufacturers association. Annual meeting to be held at Morrison hotel, Chicago. J. R. Bohnen, 80 East Jackson boulevard, Chicago, is secretary.

Jan. 9-11—

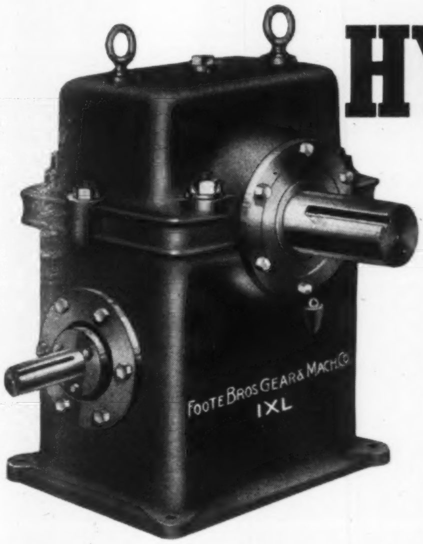
Institute of Radio Engineers. Annual meeting and exhibit to be held at Pennsylvania hotel, New York. Harold P. Westman, 330 West Forty-second street, New York, is secretary.

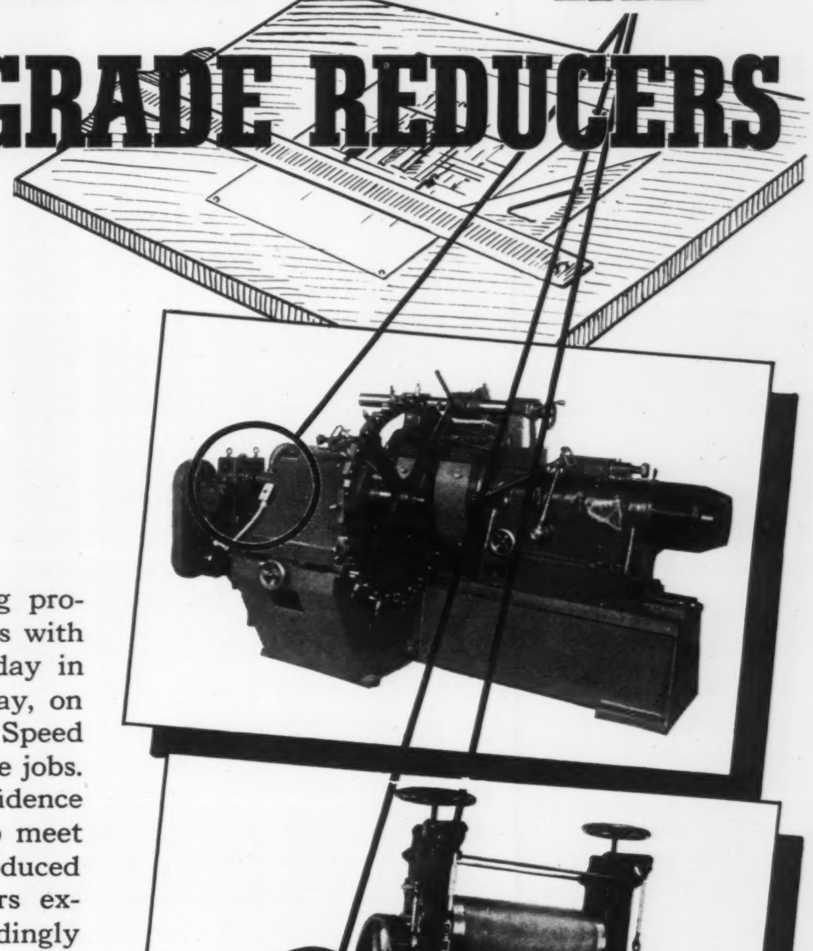
Jan. 11-13—

American Engineering council. Annual meeting to be held at Mayflower hotel, Washington. Col. L. B. Lent, 919 Seven-

(Concluded on Page 120)

FOR STAMINA use IXL
HYGRADE REDUCERS





MACHINES to meet grueling production schedules, machines with the stamina to run three shifts day in and day out — on the board today, on the job tomorrow. IXL Hygrade Speed Reducers solve the problem of those jobs. You can specify them with confidence that they're designed and built to meet the toughest demands. They're produced by an organization with 80 years experience and thousands of outstandingly successful installations behind it. No matter what kind of a reducer or gear your design demands, you can count on getting an IXL product, standard or special, to solve your problem. Tell us what you need — today.

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P. S. If you don't have the 660 page IXL Handbook "Gear Problems" at your elbow, send for it now.

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GEAR AND MACHINE CORPORATION
Established 1859
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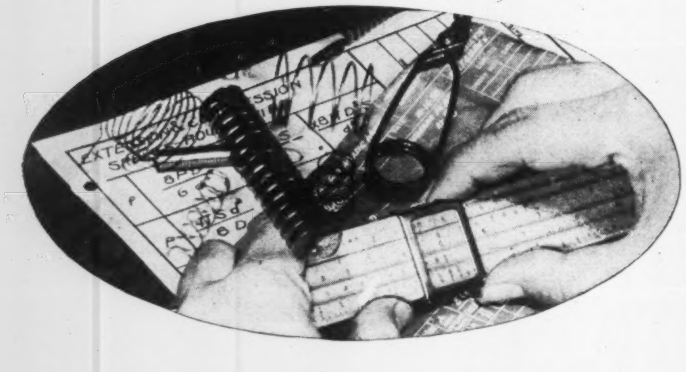

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Besides prompt, accurate handling of your routine orders, Peck Service includes intelligent engineering help on your design problems when needed. If you are having trouble in a product due to a spring or screw machine part, let us help you. Meantime,

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AND SCREW MACHINE PARTS
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PROTECTS MOTOR WINDINGS

RUTHMAN
GUSHER
COOLANT PUMPS

A patented cup disc fan built into the upper part of the motor prevents oil or dirt from getting on the motor windings—just another reason why you can expect long and efficient service from Ruthman Gusher Coolant Pumps. Gushers can be throttled to any speed without building up pressure, and they can handle cutting fluids containing grit without danger of injury.

Write for complete data sheets and see for yourself why Ruthman Gusher Coolant Pumps are so popular.

Flange - mounted type with internal discharge. Other types include: Immersed Types, Pipe Connected Types, Plain Drive Types and Tank Units. There is a Ruthman Gusher Coolant Pump to meet your needs.

THE RUTHMAN MACHINERY CO.
540 E. FRONT ST., CINCINNATI, OHIO
LARGEST EXCLUSIVE BUILDERS OF COOLANT PUMPS

(*Concluded from Page* 114)

teenth street, Washington, is secretary.

Jan. 12-16—

National Association of Dyers and Cleaners. Annual meeting and exhibit to be held at Municipal auditorium, Kansas City. J. M. Matson, Silver Spring, Md., is managing executive.

Jan. 21—

Automotive Tool and Die Manufacturers association. Annual meeting to be held at Hotel Statler, Detroit. Chester A. Gahn, 15 Boulevard building, Detroit, is secretary.

Jan. 23-24—

Northwest Petroleum association. Annual meeting and exposition to be held at Radisson hotel, Minneapolis. Elwin E. Hadlick, 616 Builders Exchange, Minneapolis, is secretary.

Jan. 27-29—

National Association of Air Filter Manufacturers. Annual meeting to be held at Muehlebach hotel, Kansas City. J. R. McConnell, 215 Central avenue, Louisville, Ky., is secretary.

Jan. 27-31—

American Road Builders association. Annual meeting and exhibit to be held at Pennsylvania hotel, New York. Charles M. Upham, Seventh Floor, International building, Washington, is engineer-director.

Hydraulic Control Affords Design Flexibility

(*Continued from Page* 40)

Fig. 6, a spring is applied to the displacement control in a direction to decrease volume taken in per revolution. A pressure-operated piston opposes this spring action and is actuated by pressure oil bleeding through a by-pass valve in the power line. The action results in maintenance of a constant pressure in the power line and is accompanied by a constant volume rate being produced by the pump. Output speed may vary with the displacement of the fluid motor, but the output horsepower remains practically constant.

These controlled and constant power devices have been found useful in marine applications such as anchor windlass and lifting crane drives, rolling mill drives, constant tension reels where diameter build-up is appreciable, and several other applications where the full power of the prime mover must be utilized at all speeds.

In *Fig.* 7 is illustrated a positive displacement variable speed transmission applied to a roll feed printing press. The variable pressure pump has an electrically actuated displacement control which may be remotely operated.

REPEATER, SIGNAL FOLLOW-UP, OR SERVO-CIRCUITS: If it is desired to cause motion of a large load in response to a relatively feeble signal by manual direction or by some sort of instrument impulse, hydraulic relay circuits are available by which signal torques or forces may be amplified many thousand fold and accurately repeated. For either a rotary or translatory servo apparatus, the simple variable speed transmission may still be used as the basis. Frequently referred to as a torque amplifier this arrangement,

We Serve on 3 "Fronts"

① *Forging* Three complete departments—steam hammer, drop and upset forging—fully equipped to produce sound forgings from any specification steel, of which we carry large stocks—forgings of any size, shape or quantity. Complete drop and upset forging die service.

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May we send our representative or bid on your next requirements? Send your blueprints.

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WORLD'S LARGEST JOB FORGING SHOP
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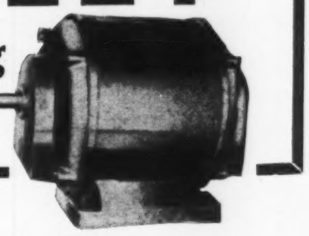
VALLEY
Ball-Bearing MOTORS



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DRIP PROOF— SPLASH DESIGN
Valley Ball-Bearing Motors are designed to meet operating conditions where hazards of liquids, chips etc., dropping into the motor, are involved. Motors are protected against this as well as against normal splash conditions.

. . . *because BETTER MOTOR DESIGN* has been the consistent aim of Valley Electric Corporation engineers throughout the years. The Valley Ball-Bearing Electric Motor of today offers definite buyer-appeal in efficiency and economy to the purchasers of your equipment. That is why prominent design engineers are incorporating Valley Ball-Bearing Motors in their plans.

Consider the importance of these five outstanding features when you order your next motor. (1) No Dead Spots. . . (2) Efficient and Ventilated Winding. . . (3) 40° C. Maximum Temperature Rise. . . (4) Squirrel-Cage Welded Rotors. . . (5) Ball Bearings.

Ball-Bearing Motors
½ to 75 Horsepower

VALLEY
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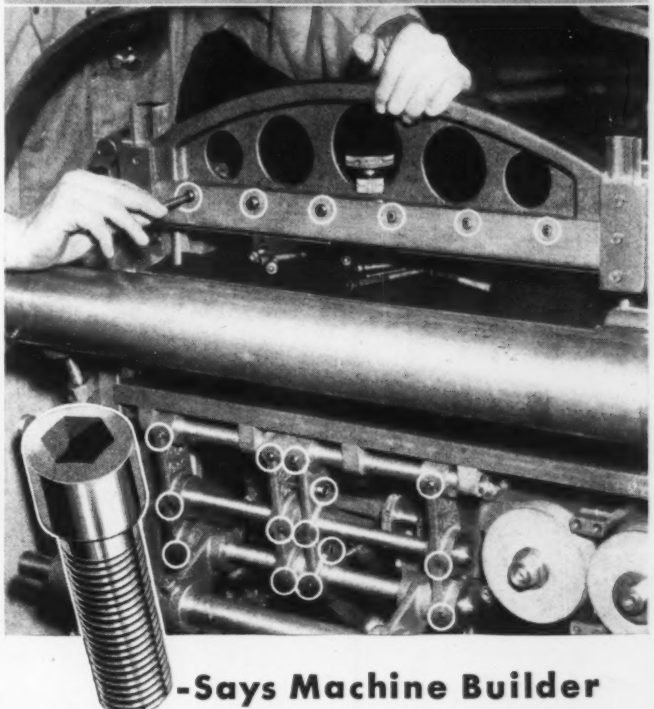
"There COULDN'T BE a bad P-K Socket Screw!"

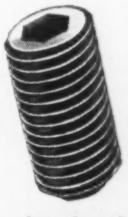


-Says Machine Builder After Visiting Parker-Kalon Quality-Control Laboratory

"My inspection trip through your quality-control department amazed me, and certainly settled the question of which socket head cap and set screws we could trust to stand the heavy torsion and other strains in our automatic spiral inserting machine," states an executive of the Spiral Binding Co. "After seeing those tests, I felt that there couldn't be a bad P-K screw . . . and in two years we have never had one fail in service or give trouble in assembly."

No less than sixteen exacting tests in the unique Parker-Kalon Quality-Control routine prevent the troubles a few "doubtful"—imperfect—screws in a lot can cause. Wise design and production men are getting the benefit of this extra protection on all fastening jobs by specifying PARKER-KALON exclusively.

WRITE today for folder describing the great Parker-Kalon Laboratory which makes it possible to maintain a new high standard in socket screws without increasing the cost. Free samples furnished on request. Parker-Kalon Corp., 192-200 Varick St., New York.

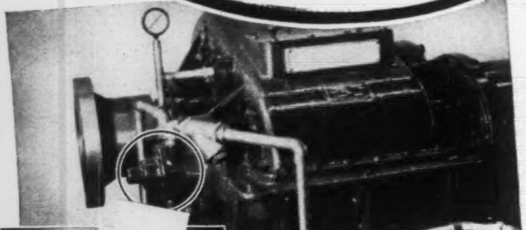


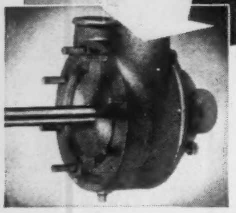
Quality-Controlled

16-point test and inspection routine covers: Chemical Analysis; Tensile and Torsional Strength; Ductility; Shock Resistance under Tension and Shear; Hardness; Head diameter, height and concentricity; Socket shape, size, depth and centricality; Class 3 Fit Threads; Clean-starting Threads.

PARKER-KALON
COLD-FORGED
Socket Screws

BUILD THE PUMP *Into* YOUR MACHINE





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Save space and money by building lubricating or coolant pumps directly into the design of your machine. Tuthill introduced "Stripped" pumps for this purpose—now supplies thousands to the field. Capacities up to 50 g. p. m. in types to meet all requirements. WRITE FOR COMPLETE INFORMATION TODAY

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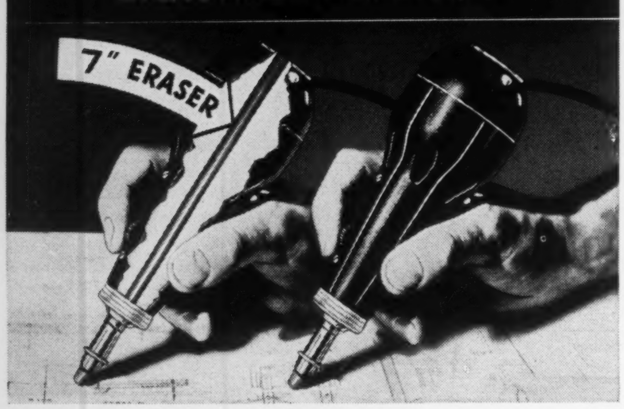
AT LAST—A "CORE FEED" ERASING MACHINE!



THE *New* BRUNING HOLLOW SHAFT ERASER!

AN ENTIRELY new principle brings to electric erasing machines the convenience of an automatic pencil! The new Bruning Eraser holds a 7" rubber core which can be fed down as needed . . . eliminating frequent eraser changes! Other advantages include:

1. SKF ball bearing chuck provides extra wear and trouble-free operation.
2. Light weight die cast aluminum housing, convenient control button.
3. Fan-cooled, long-life motor.

The Bruning Eraser soon pays for itself in drafting rooms—bookkeeping, statistical, accounting and stenographic departments, wherever fast, clean, erasing is needed. For full information write Charles Bruning Company, Inc., 100 Reade Street, New York, N. Y. 1091-198

BRUNING • *Since 1897* • Branches in 12 Principal Cities

shown in *Fig.* 8, enables a small signal impulse to control the motion of large loads. In this transmission the differential gear will move the pump stroke control from neutral whenever the output shaft departs from the position prescribed by the signal shaft. Therefore, the movement of the output shaft will be in the direction to correct such difference in position with a speed proportional to the difference. The applications are numerous, particularly where direct instrument control of large loads is desired as, for example, in automatic airplane pilots, marine steering gears and large hydraulic press control systems.

Cams May Control Operation

INTERLOCKING OR AUTOMATIC CYCLE DRIVES: When a succession of operations is to be performed according to a prearranged cycle, a hydraulic system is used containing a number of motor elements (either piston rams or fluid motors) and with each under the regulation of a control valve. By placing the control valves under the direction of a master cam, or by causing each to respond to the work of some other motor element, an infinite variety of interrelated operations may be prescribed. If desired, the several operations may be caused to take place in an automatically repeated cycle. This type of circuit is in common use on production machine tools of several kinds. The mechanisms of these machines are simpler and more accurately controlled than those of purely mechanical or electrical automatic machinery.

Current pump, motor and valve equipment is available in a considerable number of designs. Their efficiencies and costs vary greatly, but small quantity production in the industry prescribes a fairly high price level. In small horsepower capacities their use may be prohibited by price considerations and here other types of variable speed mechanisms are often used. In the larger sizes the hydraulic competes favorably in price with direct-current electrical equipment of similar capacity. With the greatly increased use that is anticipated for the near future, prices may soon be close to those of the less versatile mechanical transmissions.

Tendency Is Toward Higher Pressures

Noticeable noise and pulsation are still inherent defects in practically all hydraulic positive displacement units. Somewhat more pronounced in piston type equipment than in others, (such as the vane and gear) these handicaps sometimes prohibit its use in cases where extreme quietness or absolutely pulsation-free power are essentials. Research in this direction indicates that quiet and practically pulsation-free equipment may be expected soon.

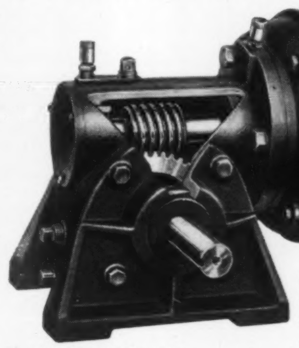
Pressure and speed limitations are being extended continually. Some equipment is already being rated at peak pressures over 3000 pounds per square inch. However, pressure-carrying capacity is by no means the most important criterion in the choice of equipment. Power capacity per unit of weight is a far better index and this measure often places lower pressure equipment ahead in effectiveness.

Janette

MOTORIZED SPEED REDUCERS

FOR SLOW SPEED DRIVES

1/50 TO 10 H.P. . . . . . . .08 TO 1140 R.P.M.



Here are a few of the features which explain their popularity among users, engineers, installation and maintenance men.

EASY TO INSTALL — A 2 point, rugged mounting base—a flange base can also be furnished—easy to line up with driven machine—16 positions available—expensive adaptors are not necessary.

EASY TO MAINTAIN — Ball bearings have separate grease cups to insure clean grease—not lubricated by gear case grease; large grease reservoir in gear case for gears, makes frequent greasing unnecessary; worm located above gear for better lubrication; the motor, bearings, oil seals and worm can be removed as a unit, by taking out 4 bolts. As motor windings are vacuum impregnated with insulating varnish, then baked 12 hours, the rotor, stator and shaft ground to size and complete unit given an individual test after assembly, trouble rarely occurs in a Janette motor.

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556-558 West Monroe Street Chicago, Ill. U. S. A.

BLUE Devil

The ARISTOCRAT of SOCKET SCREWS

Try our service on your special sizes.

1—Cold-formed heads—unimpaired continuity of fibres.

2—Tensile strength 215-225,000 lbs. per square inch.

3—Precision formed hexagon socket with true sides and no taper.

4—Chamfered edge knurled to facilitate assembly.

Blue Devil Cap Screws are unbelievably tough, and are heat treated in electrically controlled furnaces. Send for catalogue and samples.

Nothing too large - Nothing too small for

SAFETY SOCKET SCREW CORPORATION

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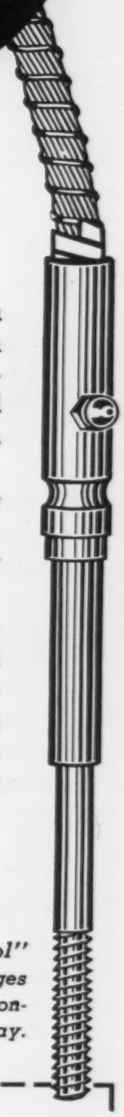
"SPOT" YOUR OPERATORS WHERE THEY CAN OPERATE

TRU•LAY PUSH-PULL CONTROLS

With **TRU•LAY Push-Pull Controls** you can have variable control points from which operators can work to best advantage. The point of control can be changed at will to meet changing requirements on the job.

TRU•LAY Push-Pull Controls instantly transmit the slightest control impulse. They hold any position to which they are set.

These controls are easily installed—merely snaked around obstructions—and are easily adapted to the remote operation of valves, clutches, switches and other mechanisms. They require no maintenance attention and can't become noisy or "sloppy" in operation.



The Key to Remote Control
TRU-LAY PUSH PULL UNIT

Send the Coupon for this **FREE BOOKLET**

"The Key to Remote Control" points out many advantages you can have in machine control. Mail the coupon today.

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Please send complete information on **TRU•LAY Push-Pull Controls.**

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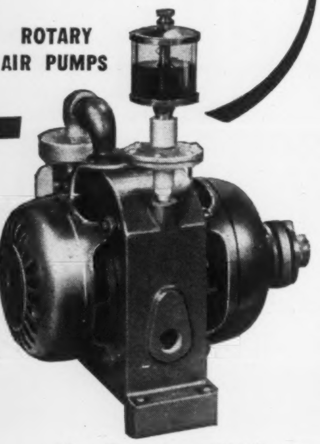
You KNOW Your
VACUUM PUMPS
Will "STAND UP" When You
Specify
"GAST" ROTARY AIR PUMPS



Improved Performance of their products is only one of the many advantages machine and equipment manufacturers gain through use of Gast Air Pumps as *standard equipment.* Outstanding Gast Air Pump performance on filling equipment, oil furnaces, laboratory apparatus, printing frames, etc., etc., is assured because of features like these:

- FORCED - AIR - COOLING — Maintains lower temperatures . . . increases unit life. No complicated water systems.
- VANES — Composition . . . no springs . . . automatic take-up for wear.
- AUTOMATIC SHAFT SEAL — No shaft packing . . . eliminates oil leakage and frequent adjustment . . . prevents vacuum loss . . . reduces friction.
- ROTOR — Does not touch casing.
- SIMPLICITY — No gears, springs or reciprocating parts.

Nine Sizes—1 to 23 C.F.M.
Vacuum to 28"
Pressures to 30 Pounds.

- COMPACT — More air delivered per pound of weight and H.P. used.
- ADAPTABILITY — Can be used as either vacuum or pressure pump.

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PUMPS

Write at Once for complete FREE Engineering Catalog and Performance Data of Gast Air Pumps. Ask for Details On Manufacturers' Discounts! Address: GAST MFG. CORPORATION, 107 Hinkley St., Benton Harbor, Mich.

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"Impossible" Designs Made Practical
with KENNAMETAL TOOLS

If you have been forced to discard a good design because the finished product could not be produced economically, ask your plant superintendent to install KENNAMETAL-tipped tools on his lathes, shapers, and boring mills . . . and watch costs go down. For KENNAMETAL machines steel of all hardnesses up to 550 Brinell at practical high speeds, while permitting close tolerances and producing a smooth finish. Annealing, grinding, and polishing operations can often be eliminated.

We will gladly show you how KENNAMETAL tools enable you to specify steel parts of greater hardness and greater accuracy—while holding production costs to a minimum. Send us B. P.'s showing desired tolerance and material to be machined.

McKENNA METALS Co.
146 LLOYD AVENUE
LATROBE, PENNSYLVANIA, U.S.A.

Business and Sales Briefs

JOHN F. DITZELL has been appointed general sales manager of Shafer Bearing Corp., 35 East Wacker drive, Chicago. For a number of years Mr. Ditzell was a sales executive of the Stewart-Warner-Alemite Corp.

◆

Oliver Smalley was unanimously re-elected president of the Meehanite Research Institute of America Inc., at its twelfth annual meeting in Milwaukee recently. Over 80 representatives of Meehanite foundries were present and more than 40 research papers were presented. Other officers re-elected include H. B. Hanley, vice president, and Frank M. Robbins, secretary-treasurer.

◆

Harold B. Thomas, one of the founders of the Elastic Stop Nut Corp., Union, N. J., has resigned as vice president in charge of sales and will enter consulting work in industrial product analysis and market research. He remains a director and member of the executive committee of the corporation.

◆

To keep pace with increasing demand for motors, fans, etc., Signal Electric Mfg. Co., Menominee, Mich., is building another new wing to its plant similar to the addition built in 1937. Over 20,000 square feet will be provided by the two-story wing, measuring 176 by 58 feet.

◆

Construction of a new warehouse on Pacific boulevard, Los Angeles, is announced by Allegheny Ludlum Steel Corp. The new building is necessitated by the growing business of the corporation on the Pacific coast and the continued increasing demands for its alloy and special steels.

◆

Opening of a New York district sales office on November 1 is announced by the Inland Steel Co. Powell Pardee is district sales manager and the office is at 40 Wall street. Mr. Pardee has been with the company since 1905 and was manager of the order department in Chicago from 1913 to 1940. He went to New York about six months ago as a special representative, in connection with export business. Both domestic and export business in the eastern territory will be handled by the New York office.

◆

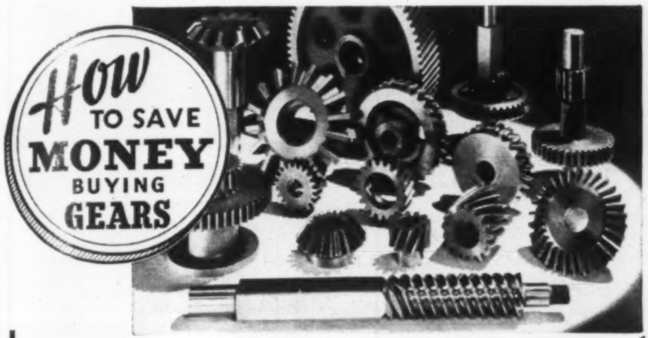
Twin Disc Clutch Co., Racine, Wis., opened a new branch office in St. Louis on November 1 to take care of increased sales of clutches, power takeoffs, marine gears and hydraulic drives. Henry Wirry of the factory engineering staff is stationed at the new office, located at 1701 Delmar boulevard. A staff of service men is also being maintained, and complete stocks of all types of replacement parts are on hand.

◆

W. T. Roundy has been transferred to the Atlanta office of Cutler-Hammer Inc. According to A. C. Gibson, manager of the Atlanta district, Mr. Roundy has been assigned to Florida and will make his headquarters at Orlando. Mr. Roundy is a graduate electrical engineer of Marquette university and has lately been a sales engineer in the company's Cincinnati and Indianapolis offices.

◆

Ward Leonard Electric Co. has opened a branch office in Rochester, N. Y., located in the Lincoln



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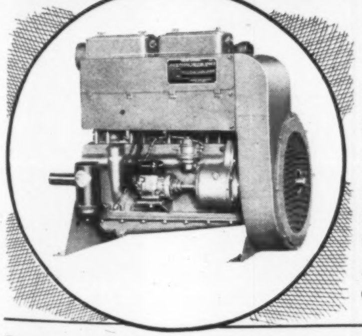

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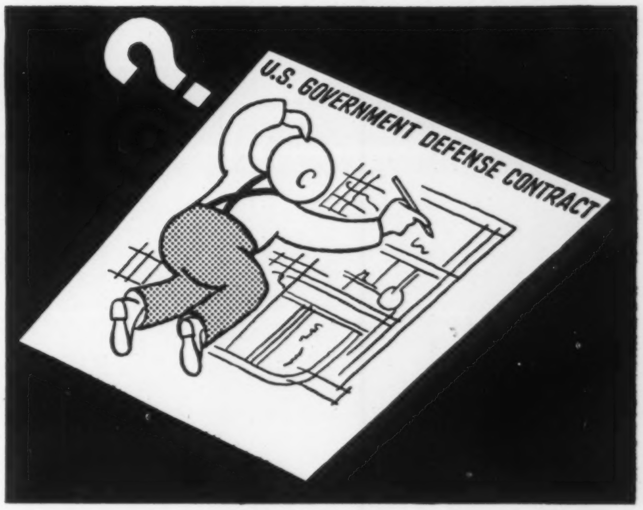
MILWAUKEE, WISCONSIN, U.S.A.



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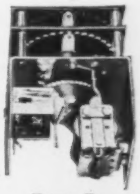
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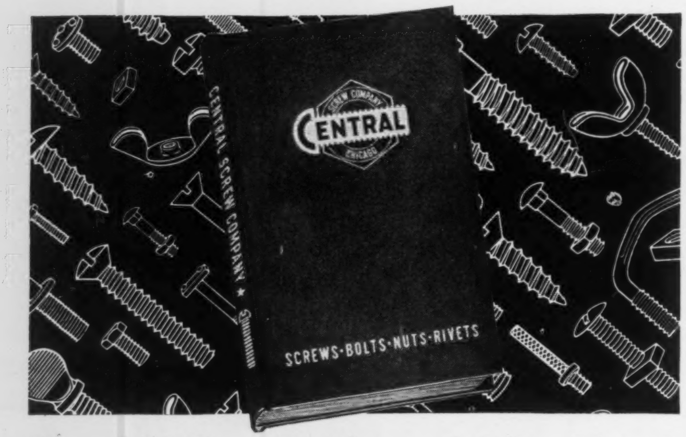

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◆

Cutler-Hammer Inc. announces opening of a new factory, warehouse and sales offices in San Francisco, at 711 Potrero avenue. A modern one-story structure, the plant has every facility for production of the Cutler-Hammer lines of electrical controls. Distribution is handled through four sales offices at Los Angeles, San Francisco, Portland and Seattle. The new building also includes large warehouse space for stocking and handling the company's line. Pacific coast sales headquarters will be located in the same building. F. H. Oberschmidt is manager of the San Francisco office and also supervises the Seattle and Portland offices.

◆

Appointment of R. S. Clingan as Chicago district manager is announced by Copperweld Steel Co., Warren, O. For the past ten years Mr. Clingan has been with Republic Steel Corp.

◆

Reorganization of its divisional sales is announced by the Blackmer Pump Co., Grand Rapids, Mich. Bruce P. Hetler, formerly general sales manager, becomes manager in charge of engineering sales and J. B. Trotman becomes general sales manager in charge of sales distribution and advertising. Mr. Trotman has had years of pump sales experience with Goulds Pumps Inc. and lately as manager for the Roots-Connersville Blower Corp., turbine pump division. When the latter company sold its small pump business, Mr. Trotman transferred to the Blackmer organization.

◆

Henry H. Timken Jr. has been named chairman of the board of the Timken Roller Bearing Co., Canton, O. He succeeds his father, the late Henry H. Timken Sr. and will continue as vice president and general manager of the Steel and Tube division. Mr. Timken has been a director for ten years.

◆

Production capacity of McKenna Metals Co., Latrobe, Pa., has more than doubled in the past few months, keeping pace with high current demand. Three new buildings have been erected.

◆

J. A. Ingwersen has been appointed manager, sheet and strip sales division, American Rolling Mill Co., Middletown, O., and F. E. Wortley has been promoted to manager of midwestern sales, succeeding Mr. Ingwersen. Joining Armco in 1923, Mr. Ingwersen has been manager of midwestern sales since 1939. Mr. Wortley was district manager at Cleveland until 1939 when he was named Mr. Ingwersen's assistant, with headquarters at Middletown.

◆

Paul J. Darling has been named sales manager of Steel Sales Corp., Chicago.

◆

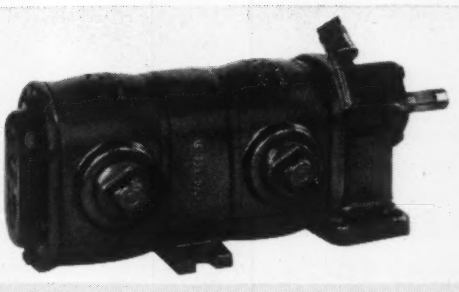
David S. Lewis has been appointed assistant to T. W. Pennington, sales manager, Jessop Steel Co., Washington, Pa.

◆

Appointment of Harvey L. Miller as district manager in Houston, Tex., is announced by Wheeling Steel Corp. Headquarters are at 2508 Gulf building. I. G. Thompson continues as district sales manager at Dallas.

◆

L. G. Atkinson has been named manager of sales of small De-ion circuit breakers, Westinghouse Electric & Mfg. Co., East Pittsburgh. After joining the company as a student engineer, Mr. Atkinson was transferred in 1936 to switchgear sales.



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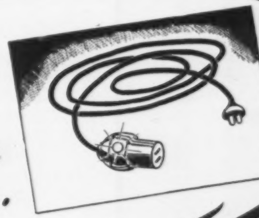
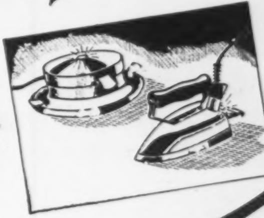


or tell when the iron is on?



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NEW MACHINES–
And the Companies Behind Them

(For illustrations of other outstanding machinery see Pages 64-65)

Air Conditioning

*Atmosphere furnace, Lithium Corp., New York.

Automotive

Rapid-type battery charger, General Electric Co., Bridgeport, Conn.

Bakery

Oven, Century Machine Co., Cincinnati.

Construction

*Concrete mixer, Chain Belt Co., Milwaukee.

Dairy

Soaker-washer, Girton Mfg. Co., Millville, Pa.
Two sizes of automatic milk fillers and cappers, Pfaudler Co., Rochester, N. Y.
Pasteurizer, Illinois Creamery Supply Co., Chicago.
Refrigerated delivery truck, Divco-Twin Truck Co., Detroit.
Homogenizer, Creamery Package Mfg. Co., Chicago.
Heat exchanger, Walter Maguire Co. Inc., New York.

Domestic

Electric table broiler, H O Electric Co., Chicago.
Gas-fired circulator, Utility Fan Corp., Los Angeles.
Automatic roaster, Swartzbaugh Mfg. Co., Toledo, O.
Automatic cabinet washer, Easy Washing Machine Corp., Syracuse, N. Y.
Bagless vacuum cleaner, Health-Mor Sanitation Systems Inc., Chicago.
*Toaster, Utility Electric Co., St. Louis.
*Electric mixer, KitchenAid Div., The Hobart Mfg. Co., Troy, O.

Finishing

Coating machine, Chas. E. Francis Co., Rushville, Ind.
Paint spray booth fan, DeBothezat Ventilating Equipment Div., American Machine & Metals Inc., East Moline, Ill.
Die finishing machine, Carboloy Co. Inc., Detroit.
Semiautomatic sandblast, Leiman Bros. Inc., Newark, N. J.

Food

Jar, can and other container filler, Food Machinery Co., Hoopestown, Ill.
Food package machine, Triangle Package Machinery Co., Chicago.
Filler-crowner, Mojonnier Bros. Co., Chicago.
Grinding mill, Abbe Engineering Co., New York.

Foundry

Jolt squeeze stripper, The Osborn Mfg. Co., Cleveland.

Glass

Glass container forming machine, Lynch Corp., Anderson, Ind.

Industrial

Hydraulic power unit, Hydraulic Machinery Inc., Detroit.
Shredding machine, Mitts & Merrill Inc., Saginaw, Mich.
Dust collector, Leiman Bros. Inc., Newark, N. J.

Laundry

Wearing apparel press, McCleary Bros. Inc., Memphis, Tenn.

Lubrication

Lubricating equipment, Alemite Div., Chicago.

Materials Handling

Power lift truck, Mercury Mfg. Co., Chicago.
Tramrail carrier, Cleveland Crane & Engineering Co., Wickliffe, O.
Link chain air hoist, Ingersoll-Rand Co., Phillipsburg, N. J.

Metalworking

Production marker, Quality Die Co., Chicago.
High-speed milling machine, J. D. Duffy & Son, Detroit.
Turret lathe, W. K. Millholland Machinery Co., Indianapolis.
Underneath-drive screw cutting machine, Brown Machine Co., Chicago.
Pipe machine, The Oster Mfg. Co., Cleveland.
Quenching machine, Hannifin Mfg. Co., Chicago.
Filing machine, Grob Bros., Grafton, Wis.
Surface grinding machine, Hanchett Mfg. Co., Big Rapids, Mich.
Horizontal milling machine, Van Norman Machine Tool Co., Springfield, Mass.

---

*Illustrated in pictorial center spread, Pages 64-65.

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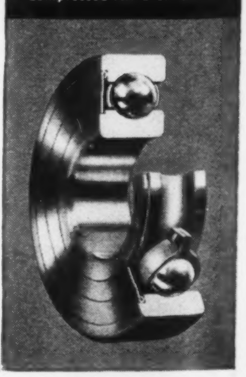

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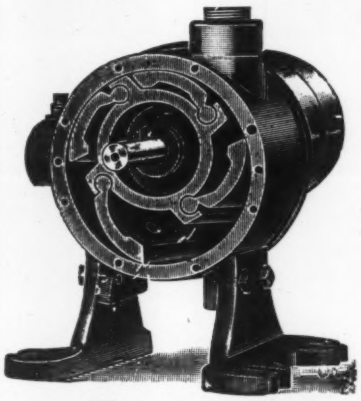

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Tool room lathe, South Bend Lathe Works, South Bend, Ind.
Shell tapper, Landis Machine Co., Waynesboro, Pa.
Cold strip mill, Farrel-Birmingham Co. Inc., Ansonia, Conn.
Variable speed lathe, Hammond Machinery Builders, Kalamazoo, Mich.
Hand-operated punch press, Leslie Welding Co., Chicago.
Production riveting machine, Chicago Rivet & Machine Co., Chicago.
*Hobbing machine, Barber-Colman Co., Rockford, Ill.
*Wire forming and cutoff machine, Unit Machinery Co., Rockford, Ill.

Mining

Classifiers, Morse Bros. Machinery Co., Denver, Colo.
High-speed, electric-driven rock drill, Sullivan Machinery Co., Michigan City, Ind.
Coal dryer, McNally-Pittsburgh Mfg. Corp., Chicago.
Rotary air motor jack, Duff-Norton Mfg. Co., Pittsburgh.
Excavator, Thew Shovel Co., Lorain, O.

Office

Telescriber, TelAutograph Corp., New York.
Tabulating machine, Remington Rand Inc., Buffalo, N. Y.
Adding-figuring machine, Underwood Elliott Fisher Co., New York.
Figuring-listing machine, Barrett Adding Machine Div., Lanston Monotype Machine Co., Philadelphia.
Time stamper, International Business Machines Corp., New York.

Packaging

Double ribbon mixers, H. K. Porter Co. Inc., Pittsburgh.
Automatic capping machine, Elgin Mfg. Co., Elgin, Ill.
Automatic rotary cleaner, U. S. Bottlers Machinery Co., Chicago.
*Automatic labeling machine, Pneumatic Scale Corp. Ltd., Quincy, Mass.

Paper

Flow box and combination slice machine, The Pusey & Jones Corp., Wilmington, Del.

Plastic

Molding machine, Warren Lamp Co., 2345 Weston St., Warren, Pa.

Printing

Vertical press, Miehle Printing Press Mfg. Co., Chicago.
Camera, Litho Equipment & Supply Co., Chicago.
*Mat roller, Goss Printing Press Co., Chicago.

Quarry

Quarry plant, Universal Crusher Co., Cedar Rapids, Ia.
Crusher, Gilson Bros. Co., Fredonia, Wis.

Rubber

Cutting machine, Spadone Machine Co., New York.

Stamping

Nameplate stamping machine, H. O. Bates, Elizabeth, N. J.

Testing

Latex foam cushion testing machine, U. S. Rubber Co., Mishawaka, Ind.

Vending

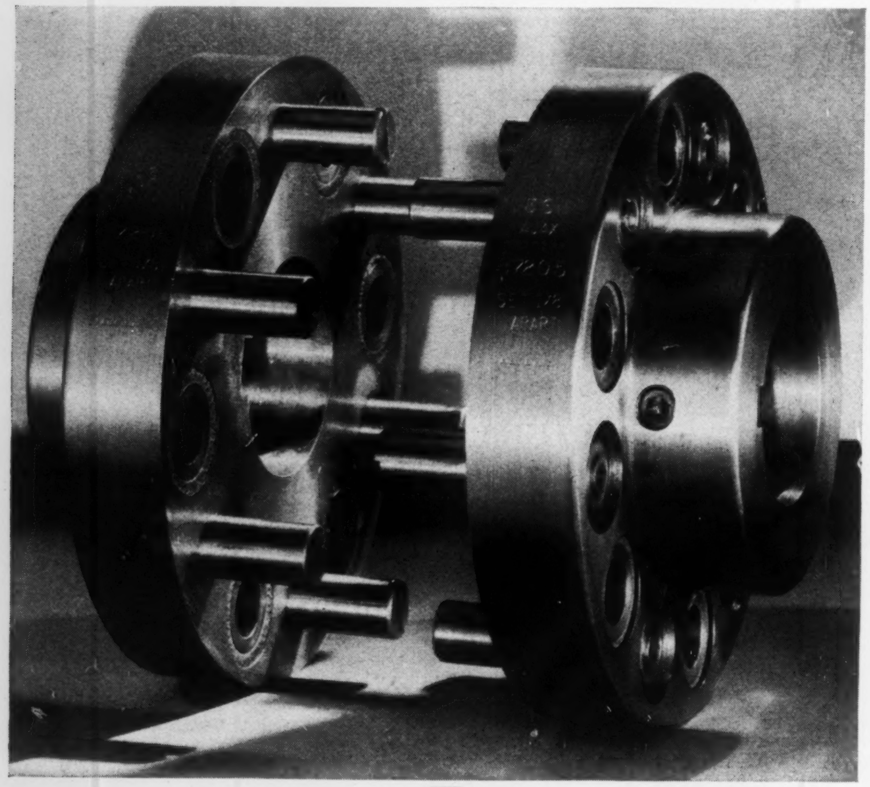
Antiaircraft machine gun game, J. H. Keeney & Co., Chicago.
Automatic phonograph, John Gabel Mfg. Co., Chicago.
*Ice cream vendor, Revco Inc., Adrian, Mich.

Welding

Low current electronic welder, Allis-Chalmers Mfg. Co., Milwaukee.
Spot welders, Acme Electric Welder Co., Huntington Park, Calif.
*Welding rod hopper feeding machine, Moslo Machinery Co. Inc., Cleveland.
Portable arc welder, Westinghouse Electric & Mfg. Co., East Pittsburgh.
Spot welding unit, Progress Welder Co., Detroit.

Woodworking

Electric hand saw, Porter-Cable Machine Co., Syracuse, N. Y.
Electric sander, Detroit Surfacing Machine Co., Detroit.
Sander, Skilsaw Inc., Chicago.



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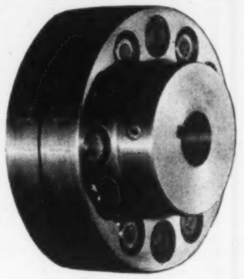

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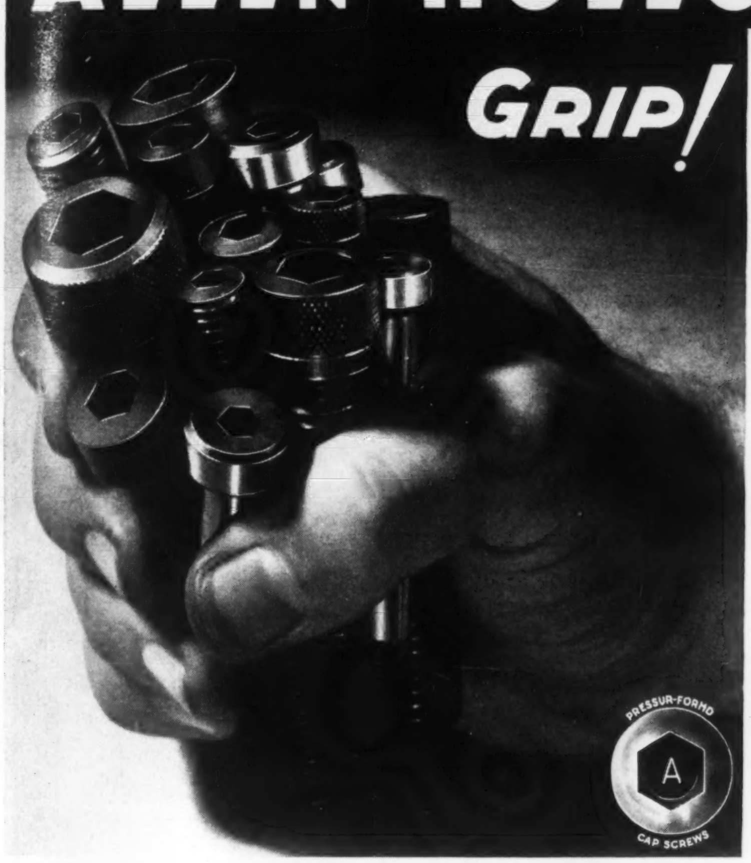
ALLEN HOLLOW SCREWS



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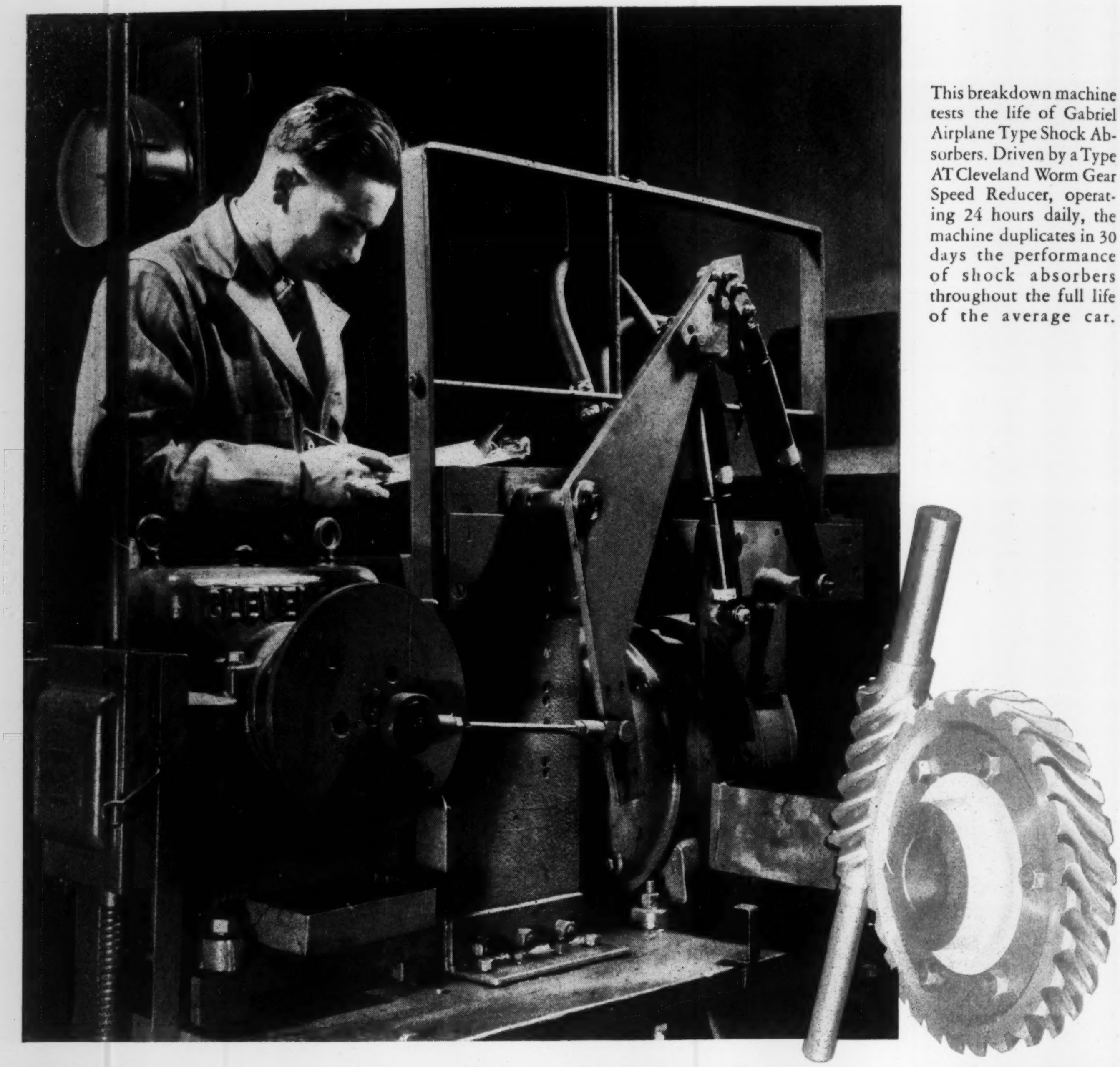
Machine Drives and Controls

All forms of drives and controls... their selection and application... are covered extensively in this removable supplement to **MACHINE DESIGN's** *April, 1940 issue*



This breakdown machine tests the life of Gabriel Airplane Type Shock Absorbers. Driven by a Type AT Cleveland Worm Gear Speed Reducer, operating 24 hours daily, the machine duplicates in 30 days the performance of shock absorbers throughout the full life of the average car.

24 hours a day, for 4,221 days . . . *So Far*

All day and all night, through weeks, months, years, this Cleveland Worm Gear Speed Reducer spins quietly along—driving a breakdown test machine for shock absorbers in The Gabriel Company's experimental department.

Requiring virtually no attention at all, this Cleveland has been at work nearly 12 years—driving the machine continually at speeds varying from 62.5 to 150 strokes per minute. Total "replacements" since purchase in 1928 have been limited to *a single gasket.*

Whatever your applications for drives, your customers need the trustworthy, unfailing delivery of power that Clevelands give. The above installation is typical of the performance that Cleveland owners expect—*and get.*

Specify Clevelands with confidence—we have been building Worm Gear Drives *exclusively* since 1912! The Cleveland Worm & Gear Company, 3265 East 80th Street, Cleveland, Ohio.

Affiliate: The Farval Corporation, Cleveland, Manufacturers of Centralized Systems of Lubrication

In Canada: PEACOCK BROTHERS LIMITED

CLEVELAND

WORM GEAR *Speed Reducers*

...OUT OF THE BEATEN PATH...
Copperspun TO MAKE A FINER MOTOR

THIS is a picture of a rotor from a Fairbanks-Morse Motor

Notice the squirrel cage winding!

It is of copper. The *one* metal most desirable, electrically and mechanically, for meeting the severe service a modern motor must withstand. Copper, the *one* metal of low resistance and low thermal expansion—best able to withstand high temperatures caused by constant plugging and reversing service.

Note further that this copper is *centrifugally cast* into a one-piece winding. *Centrifugally cast* to imbed the winding into the core slots deeply and tightly.

Then, after casting, this rotor is machined and dynamically balanced to the famed Fairbanks-Morse standards of precision.

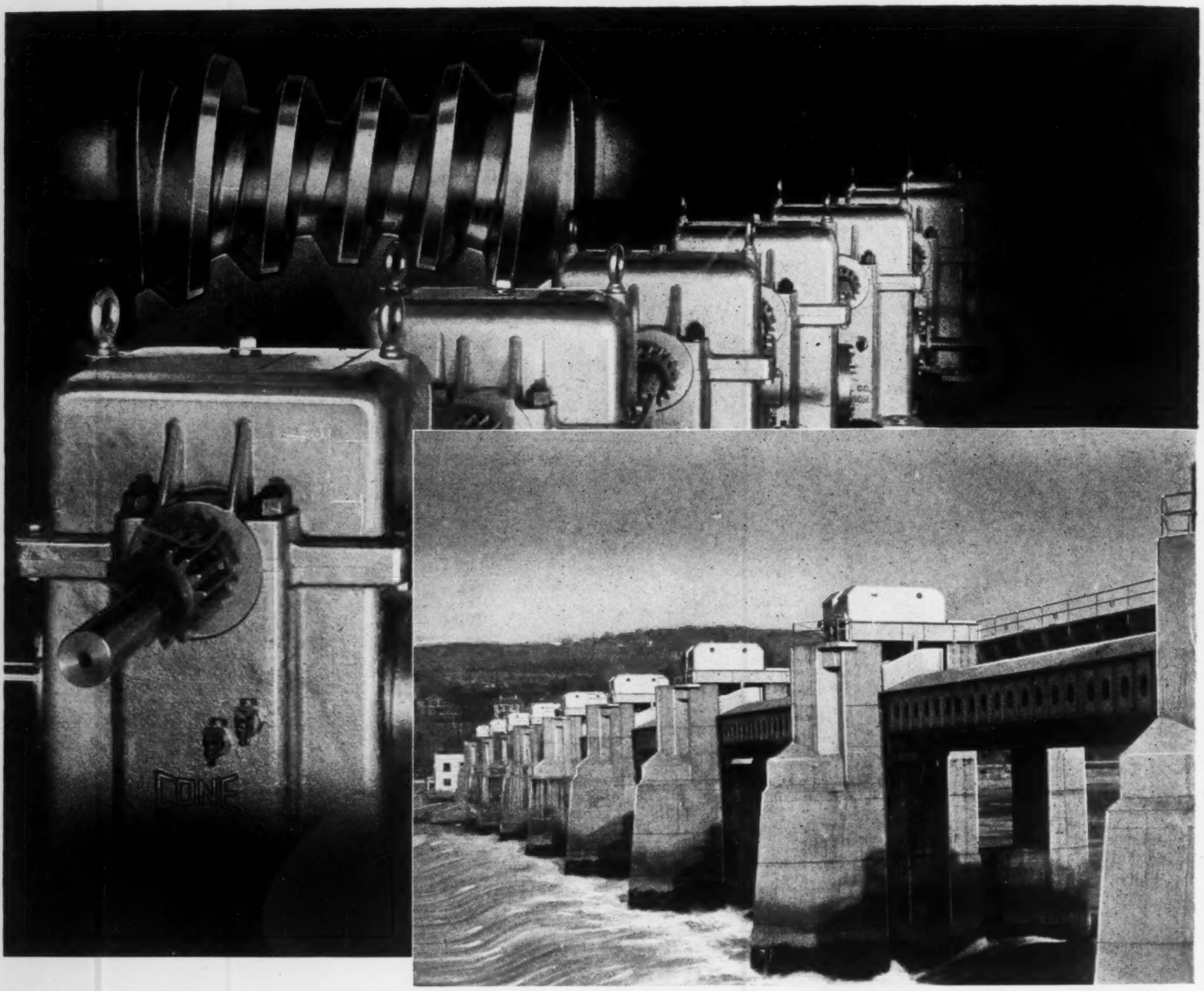
Only Fairbanks-Morse makes rotors with copper windings which are centrifugally cast. The Copperspun Rotor is an exclusive Fairbanks-Morse development, process, and feature.

For complete information on F-M Motors with Copperspun Rotors, write Fairbanks, Morse and Co., 600 S. Michigan Ave., Chicago, Ill. Branches and service stations throughout the United States and Canada.

7708-EA40.153

FAIRBANKS-MORSE MOTORS

DIESEL ENGINES ELECTRICAL MACHINERY RAILROAD EQUIPMENT WASHERS-IRONERS STOKERS PUMPS FAIRBANKS SCALES WATER SYSTEMS FARM EQUIPMENT AIR CONDITIONERS

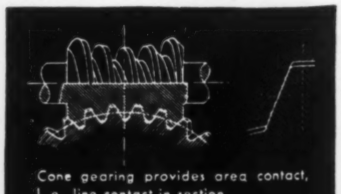


Cut Speed Reducer Size, Weight and Cost with Cone-Drive

An important flood-control dam was under construction. Each of its gates, weighing a half million pounds, had to be lifted by two speed reducers. The job called for 18 inch center-distance reducers using conventional worm gearing.

Figures showed, however, that with Cone-Drive Worm Gearing 10 inch C.D. was ample to handle the load with reserve capacity. Thus Cone-Drive's double enveloping design—its vastly greater contact area and lower unit stresses—cut reducer size and weight to less than half, with considerable saving in cost.

Those 10 inch Cone-Drive Reducers—29 of them—have been in continuous service now for better than two years. They are operating sweeter today, if anything, than when they were installed, for Cone-Drive wears "in" instead of "out."



Cone gearing provides area contact, i. e., line contact in section.

Conventional worms have line contact, i. e. point contact in section.

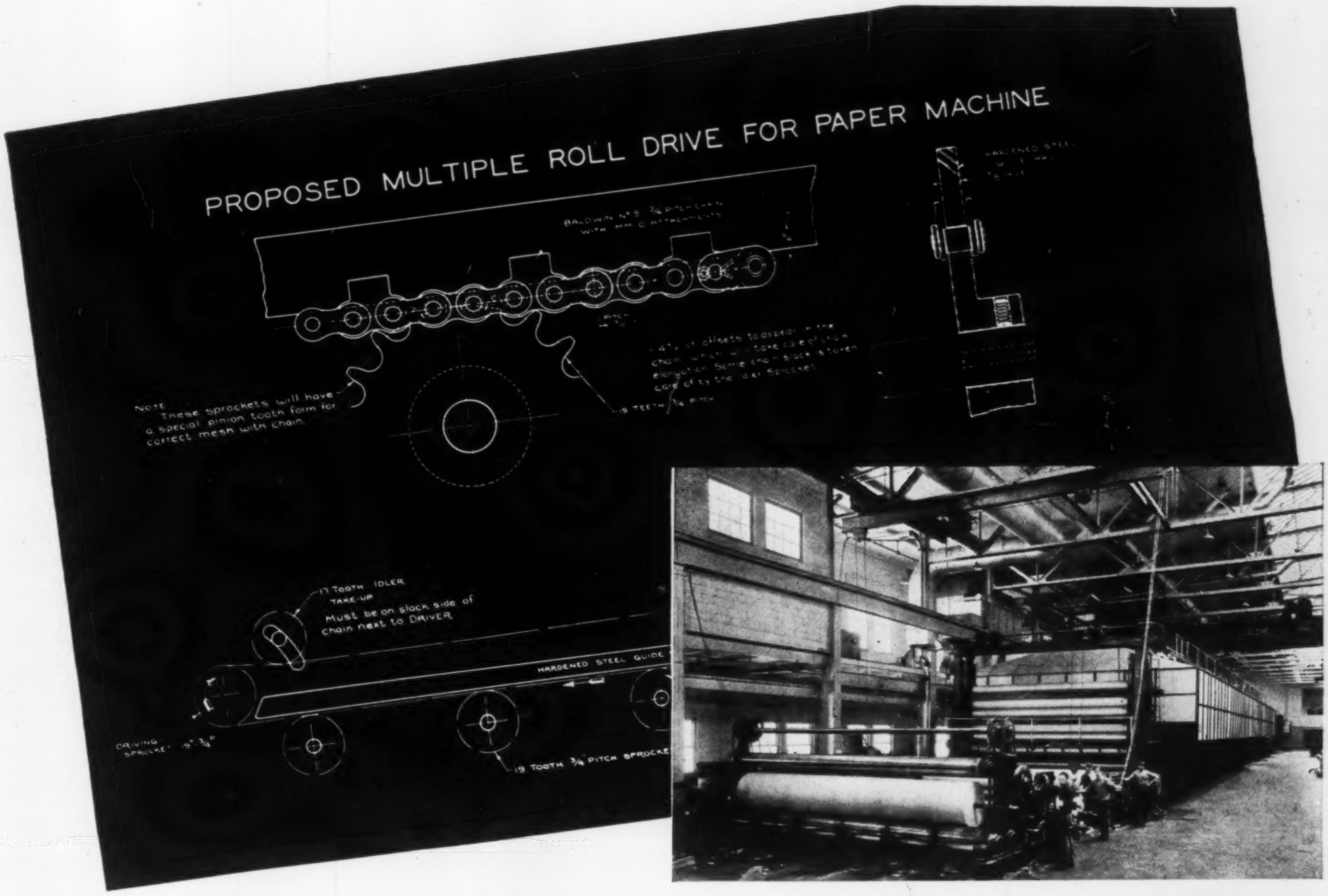
CURRENT CONE OPERATING RANGES

Ratios....Low, 1 to 6; High, 180 to 1
Speed...Low, 1/15 rpm.; High, 30000 rpm.
Sizes (C. D.) Low, 5/8 in.; High, 27½ in.

We will be glad to send you information on the Standard Cone-Drive Speed Reducer line. Ask for bulletin HU-40.

CONE WORM GEAR DIVISION

MICHIGAN TOOL COMPANY
7171 E. McNICHOLS ROAD, DETROIT, MICH.

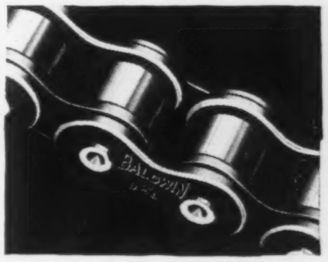

PROPOSED MULTIPLE ROLL DRIVE FOR PAPER MACHINE
BALDWIN Nº 8 ¾ PITCH CHAIN WITH MM-O ATTACHMENTS
NOTE These sprockets will have a special pinion tooth form for correct mesh with chain.
19 TEETH ¾ PITCH
17 TOOTH IDLER TAKE-UP
Must be on slack side of chain next to DRIVER
HARDENED STEEL GUIDE
DRIVING SPROCKET 19T-¾P
19 TOOTH ¾" PITCH SPROCKET

PLANNED FOR PROFITABLE PAPER MAKING

Our files are full of 'em—blueprints of chain belts we've developed for everything from sawing coal to cracking walnuts, cutting out shoe leather to driving cake wrapping machines. In many cases, they hurdled design problems where no economical or practical solution had seemed possible.

Here, for instance, is a Baldwin chain belt for a paper roll drive. Before its proposal, the manufacturer was faced with jerky, unsure power transmission that all but doomed his plan for lower cost paper making.

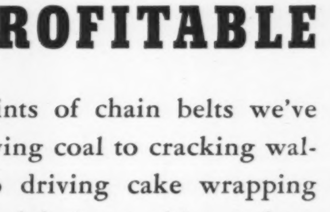
Wherever you have a problem that demands quiet, positive power transmission at constant or varying speeds, or the ability to absorb shocks, and immunity to dust and dirt, call in the Baldwin man! His skilled application of Baldwin roller chain belts to your particular problem will open your eyes to a great way to gain all these qualities.



WANT QUIET, POSITIVE POWER? TRY BALDWIN CHAIN BELTS

No drive is so positive and yet so quiet and economical as a roller chain belt. Baldwin has exceptional experience in the design, manufacture and application of roller chain belts in all standard and specialized drives and conveyors. Take advantage of this background—call the Baldwin man!

BALDWIN
CHAIN BELTS



Address inquiries to:

BALDWIN-DUCKWORTH
Division of Chain Belt Company
320 Plainfield Street, Springfield, Mass.
Factories at Springfield and Worcester, Mass.

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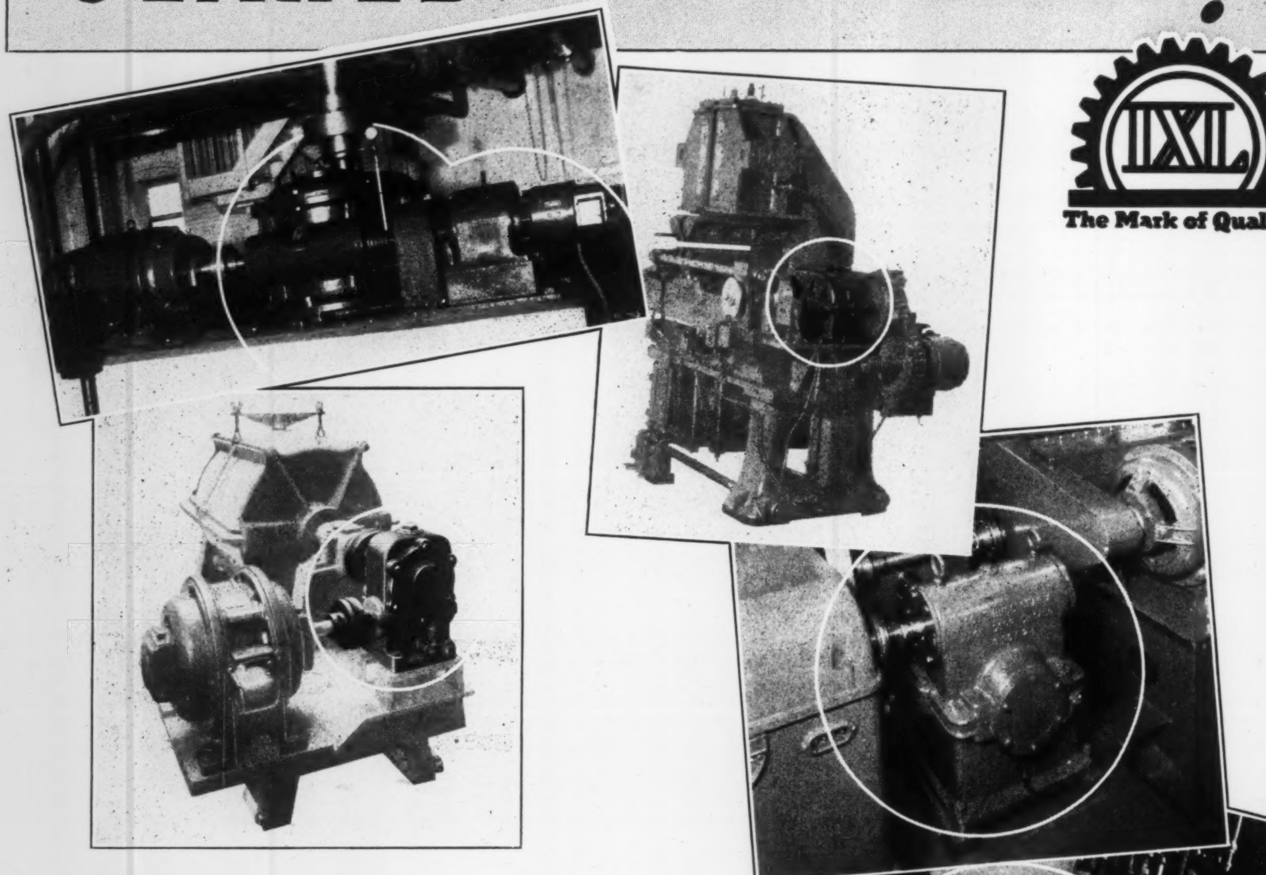
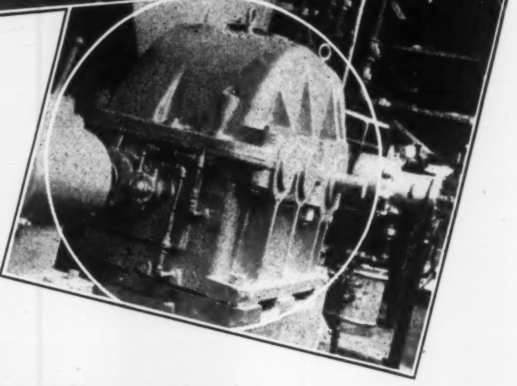
IXL
The Mark of Quality





ENDURANCE is defined: "state or capability of lasting; continuance." That's what industry must have in its equipment to assure steady production and to keep costs down. It's the reason why only perfectly engineered, carefully built, and time-proved products, like IXL speed reducers, are chosen to do the tough jobs.

Behind every IXL unit is over 80 years of gearing experience — up-to-the-minute manufacturing facilities — a policy of rigid testing and inspection — skilled engineers . . . no wonder the IXL symbol stands for quality and dependable performance!

Whatever your problem of speed reduction may be—grueling service in your plant or as a part of equipment you build to sell—solve it the most efficient and economical way—*the IXL way!* Then you can be sure that you have "geared for endurance". Ask to see an IXL engineer.

ASK ABOUT

IXL
'FIVE-POINT'
Deephard
STEEL

If you want increased wear life without sacrificing strength and ductility, look into Five-Point Deephard Steel products manufactured by Foote Bros.

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GEAR AND MACHINE CORPORATION

Established 1859

5303 SO. WESTERN AVE., CHICAGO, ILL.

A complete line of speed reducers, powered gears, special drives and gears of all kinds.

SEND FOR THIS TODAY!

GEAR PROBLEMS AND IXL SPEED REDUCERS

Send for this valuable 600 page handbook, "Gear Problems". Free to executives and engineers.

Select a WAGNER MOTOR *and be sure of the RIGHT Motor for the job*

No matter what type of equipment you are designing...whether large or small...regardless of the torque, speed or current requirements, you can choose a motor from the Wagner line that is correctly engineered for the job. The twelve motors shown here are merely representative of the Wagner line. Each motor has special electrical or mechanical characteristics that make it the ideal motor for certain applications.

1. Type RP—Available in 7 electrical types: Normal-Torque, Normal-Starting-Current; Normal-Torque, Low-Starting-Current; Low-Torque, Low-Starting-Current; High-Torque, Low-Starting-Current; High-Torque, Normal-Starting-Current; High-Torque Punch-Press; High-Torque Elevator; High-Torque Crane and Hoist.

2. Type CP—Available in the same 7 electrical types as the RP. Totally-enclosed for protection against dust, fumes and moisture. Double-frame construction. Fan mounted between outer frame and dust-proof inner frame cools the motor.

3. Type HP—Explosion-Proof motors have been approved by the Underwriters' Laboratories for Class 1, Group D hazardous locations where gasoline, petroleum, naphtha, alcohols, acetone, lacquer solvent vapors and natural gas are manufactured, used or handled.

4. Type RS—For constant or adjustable varying speeds on elevators, cranes, hoists, crushers, triplex pumps. Start heavy loads smoothly without objectionable line disturbances. Smooth starting and varying speeds are effected by the use of external resistors.

5. Type RT—Developed to meet the demand for a motor with high starting-torque and very low starting-current. Ideal for large compressors. The very low starting-current permits across-the-line starting.

6. Type RN—For power-factor correction and constant speed at all loads. High starting-torque and high pull-in torque.

7. Type RA—Brush-lifting motors having high starting-torque and low starting-current. The ideal motor for heavy duty application such as mechanical refrigeration, air-compressors, pumps, stokers, etc. Sleeve or ball bearings; open, totally-enclosed and drip-proof; rigid, resilient and flange mounting.

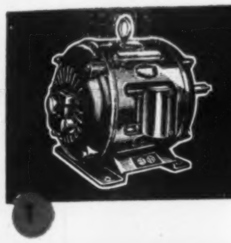
8. Type RG—Brush-riding motors with high starting-torque and normal starting-current. These motors have smooth starting characteristics.

9. Type RB—Extremely quiet in operation and particularly adapted for oil-burners, unit-heaters, fans, blowers, and hundreds of other home, office and factory appliances. Sleeve or ball bearings; open, drip-proof or totally-enclosed; rigid, resilient and flange mounting.

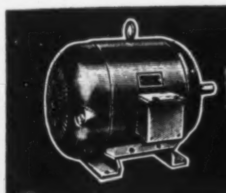
10. Type RK—Suitable for driving refrigerators, household air-conditioners, stokers, oil-burners and other similar types of equipment. Drip-proof or totally-enclosed endplates; rigid or resilient mounting.

11. Type M—Induction motor of simple construction. Ideal for fan and blower drives in which the fans are mounted directly on the motor shaft. Totally-enclosed and open type; rigid or resilient mounting.

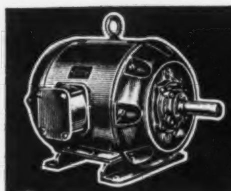
12. Type RD—For direct current service. Built in two types; appliance type up to 1½ hp; industrial type, 2 and 3 hp.



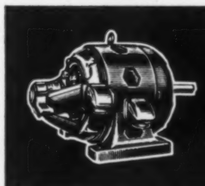
Type RP
Squirrel-Cage
Open—Ventilated
1/6 to 400 hp
Polyphase
1



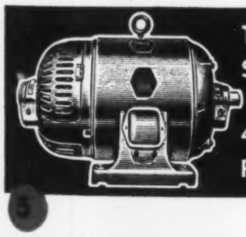
Type CP
Squirrel-Cage
Totally-Enclosed, Fan-Cooled
1½ to 125 hp
Polyphase
2



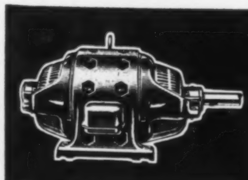
Type HP
Explosion-Proof
1½ to 125 hp
Polyphase
3



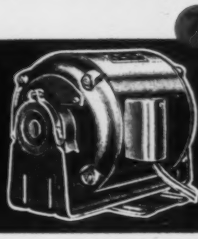
Type RS
Wound Rotor
(Slip-Ring)
1 to 250 hp
Polyphase
4



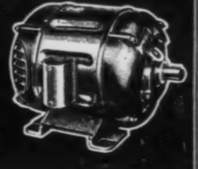
Type RT
Special Compressor Motor
40 to 100 hp
Polyphase
5



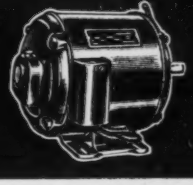
Type RN
Fynn-Weichsel
(Synchronous)
7½ to 200 hp
Polyphase
6



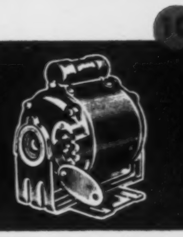
7
Type RA
Single-Phase
Repulsion-Start-Induction
1/8 to 15 hp



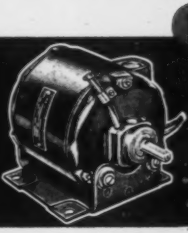
8
Type RG
Single-Phase
Repulsion-Induction
1 to 5 hp



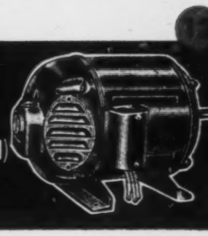
9
Type RB
Split-Phase
General Purpose
1/20 to 1/3 hp



10
Type RK
Single-Phase
Capacitor-Start,
Induction-Run
1/8 to 3/4 hp



11
Type M
Single-Phase
Shaded-Pole
Fan Motor
1/250 to 1/30 hp



12
Type RD
Direct-Current
(Compound Wound)
1/8 to 3 hp

Send for these Free Motor *Bulletins* MU-177, 179 & 182 *Today*

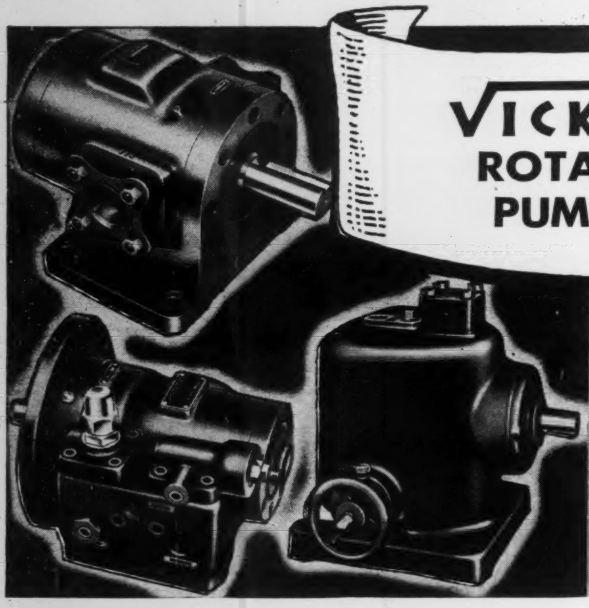
M40

Wagner Electric Corporation

6400 Plymouth Avenue, Saint Louis, Mo., U.S.A.

MOTORS • TRANSFORMERS • FANS • BRAKES

Use VICKERS HYDROMOTIVE CONTROLS ★ ★



VICKERS ROTARY PUMPS

SINGLE VANE PUMPS
DOUBLE VANE PUMPS
TWO-PRESSURE VANE PUMPS
TWO-STAGE VANE PUMPS
VARIABLE DELIVERY PISTON PUMPS

The right pump for each oil hydraulic circuit may be selected from the Vickers line. There are operating pressure ranges to 1000, 2000, or 3000 lbs. per sq. inch. Constant delivery, variable delivery or combination pumps for each individual requirement are of standardized design, all having many exclusive engineering features.

VICKERS PRESSURE CONTROLS

RELIEF VALVES
SEQUENCE VALVES
UNLOADING VALVES
COUNTERBALANCE VALVES
REDUCING VALVES

Valves for limiting of maximum pressure, for controlling a sequence of operations with pressure build-up, for automatically dropping pump pressure between cycles, and for governing many other pressure controlled operations are available. There are many size and construction modifications.

VICKERS VOLUME CONTROLS

NON-ADJUSTABLE FLOW CONTROL VALVES
ADJUSTABLE FLOW-CONTROL VALVES
FLOW CONTROL AND CHECK VALVES
FLOW CONTROL AND OVERLOAD RELIEF VALVES

The exclusive "hydrostatic control" principle which makes Vickers Flow Control Valves independent of pressure variations is used in all designs. There are types which are used for metering-in circuits and others for "locked" or metering-out circuits.

• VICKERS INCORPORATED •

★ ★ *for* CUSTOM DESIGN USING STANDARDIZED UNITS

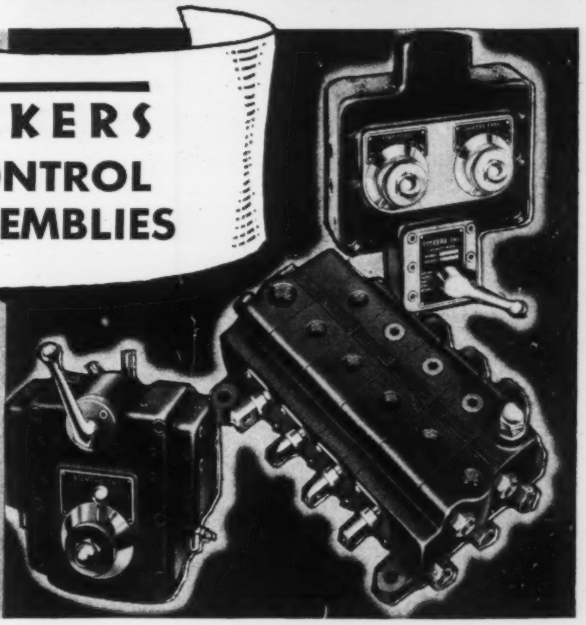
FOUR-WAY VALVES
SERVO VALVES
PILOT VALVES
TIME DELAY VALVES
CHECK VALVES

VICKERS DIRECTIONAL CONTROLS

Every conceivable valve requirement for controlling the direction of flow in hydraulic circuits can be met by the many Vickers controls available for the purpose. Manual, mechanical, hydraulic or electrical operation can be furnished. There are a wide range of sizes with threaded, gasket or flange connections.

UNLOADING, RELIEF AND CHECK VALVES
TRAVERSE AND FEED CYCLE PANELS
RECIPROCATING CYCLE PANELS
SPECIAL CYCLE PANELS
MULTIPLE-UNIT VALVES

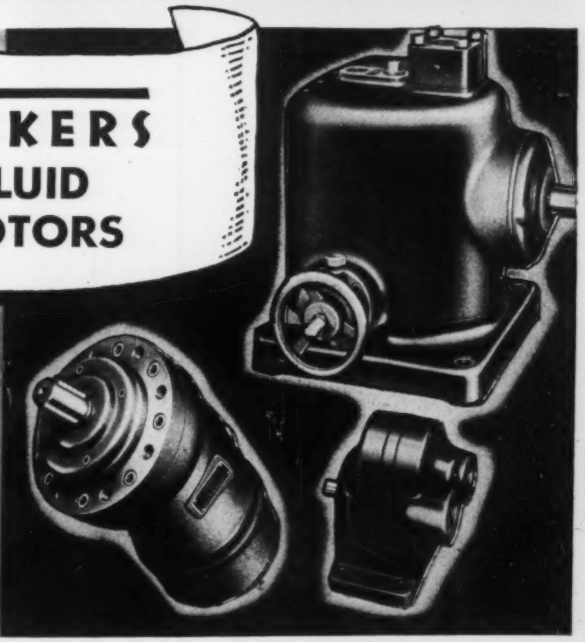
VICKERS CONTROL ASSEMBLIES



Vickers Control Assemblies and Panels combine several valving controls into a single unit, and meet the more standard machine cycle requirements with an absolute minimum of piping. Panels for "rapid traverse and adjustable feed" cycles are supplied with many variations for remote control.

CONSTANT DISPLACEMENT GEAR MOTORS
CONSTANT DISPLACEMENT PISTON MOTORS
VARIABLE DISPLACEMENT PISTON MOTORS

VICKERS FLUID MOTORS



Conversion of hydraulic power into rotary power is accomplished with high efficiency by Vickers Fluid Motors. Both variable torque and variable horsepower types are available. These fluid motors when used with Vickers pumps are furnished as complete self-contained hydraulic transmission units having custom variable speed and power characteristics.

1430 OAKMAN BLVD., DETROIT, MICHIGAN

PREMIUM PULLING POWER COUNTS MOST... AND COSTS LESS WITH

Dayton
COG·BELTS

COOLER RUNNING DAYTON V-BELTS with Daytex Cord *do* "carry the mail" at top speed, but since it's the extra power that counts most, we are prepared to prove that Daytons stand up under constant high speed flexing to give you premium pulling power at lower cost.

It took a long time (seven years, in fact) for Dayton's famed technical laboratories to develop Dayton V-Belts with Daytex Cord in their neutral axis section. But it was time well spent!

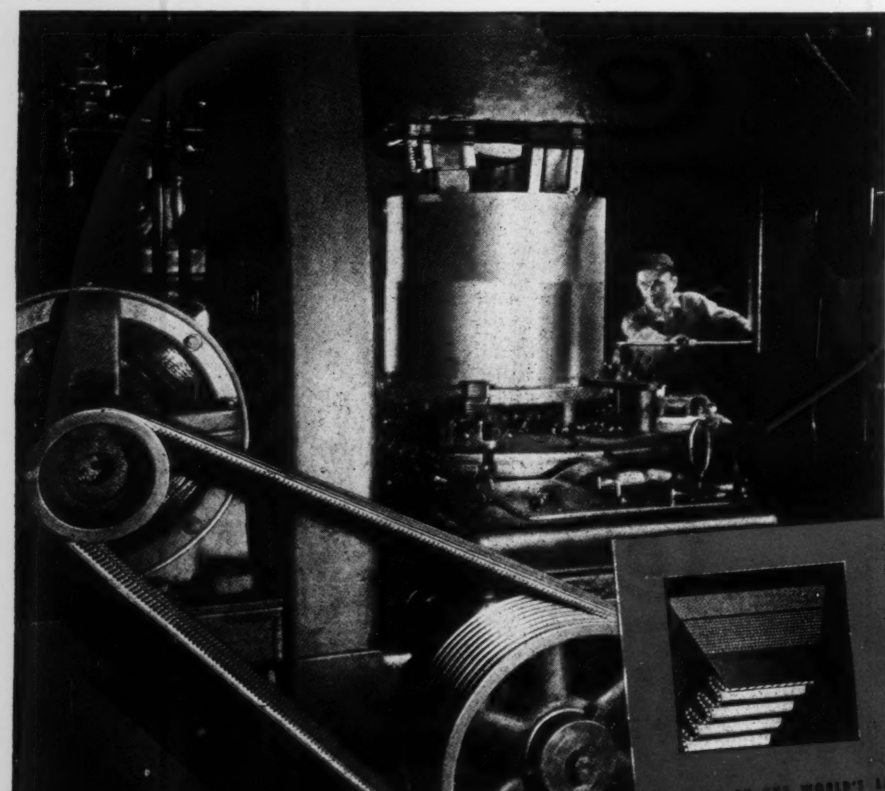
Exhaustive laboratory tests first proved that Daytex Cord has less stretch, longer life and greater strength than the best comparable cord *not* Daytex processed.

But Daytons' ability to *consistently* deliver premium pulling power at less cost per day, has been proved beyond question by countless field applications of every conceivable type—under all conditions—in all climates and places—in all types of industries.

Dayton V-Belts *are* outstanding in basic design because they are built to bend with patented cog construction. They work on short centers and save space. They reduce adjustments to a negligible minimum. They last longer and increase output—reduce expense—maintain machine speed and prevent power waste.

Ask your local Dayton distributor for catalogs, data and "The Picture Story of Daytex Cord."

THE DAYTON RUBBER MFG. CO.
DAYTON, OHIO

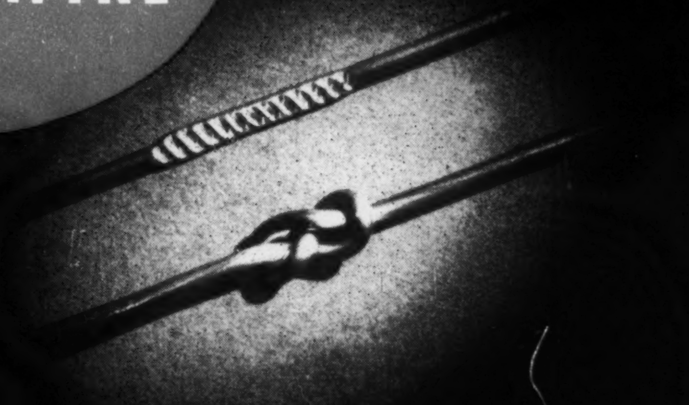


Dayton
COG·BELT DRIVES
WITH DAYTEX CORD
MADE BY THE WORLD'S LARGEST D MANUFACTURER OF V-BELTS

FORMEX

REG. U.S. PAT. OFF.

MAGNET WIRE



TOUGH!

HIGHER WINDING SPEEDS---
FEWER REJECTS---LOWER COSTS

YOU'D never abuse wire by stamping it in a die or twisting it in a knot. But these simple tests illustrate the resistance of Formex wire to the rough usage encountered in high-speed-winding and assembly operations. The result is sizable savings.

Actually, the real savings begin earlier. In first cost, for example. As compared with single cotton enameled in most sizes, Formex wire is priced less per pound, and you always get more feet in a pound. It also takes up less coil space, and thus saves copper.

When you consider its other properties, too—such as resistance to stretch and to heat aging, high dielectric strength, and low dielectric losses—you can see why Formex wire has upset all existing magnet-wire standards. It's new, and it means change—opportunities for making profitable improvements in design.

For details, see Bulletin GEA-2973. Also ask for samples. Address nearest G-E sales office or General Electric, Dept. 6D-201,
Schenectady, N. Y.

FORMEX WIRE IS A PRODUCT OF GENERAL ELECTRIC RESEARCH

GENERAL ELECTRIC MAGNET WIRE

ALWAYS THE RIGHT TYPE FOR EACH JOB

GENERAL ELECTRIC

This Mighty Arm

"Makes its Muscle"

with WHITNEY ROLLER CHAINS

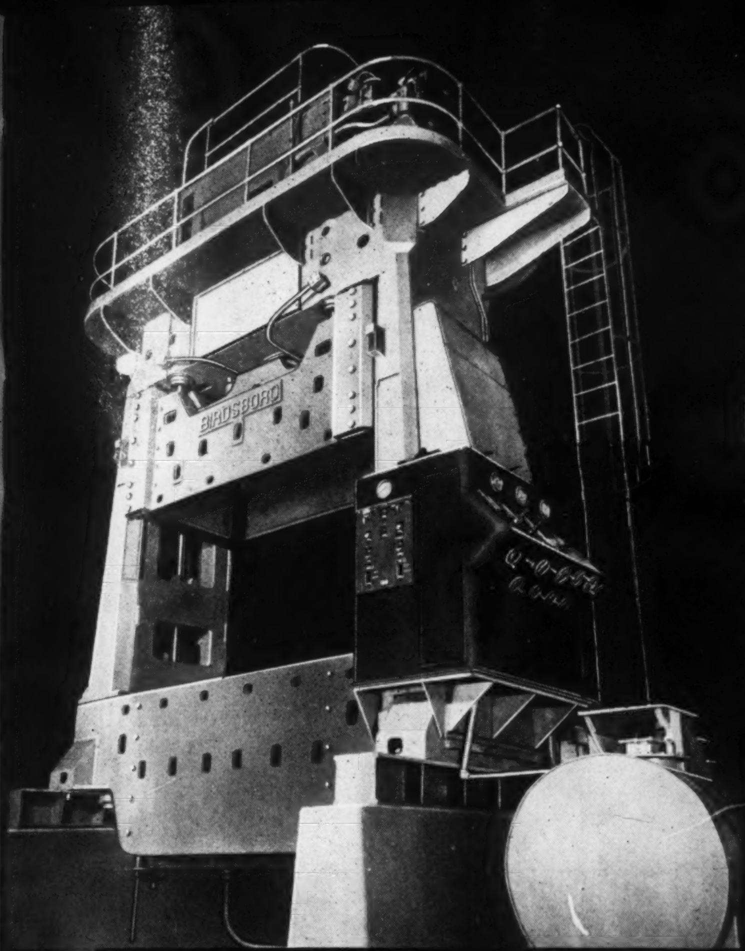
THIS YALE & TOWNE heavy-duty ram truck is specially designed to handle rolls of sheet steel from the rolling mill. For such work, the 25,000-lb. monster must be "physically fit" in every part of its massive anatomy.

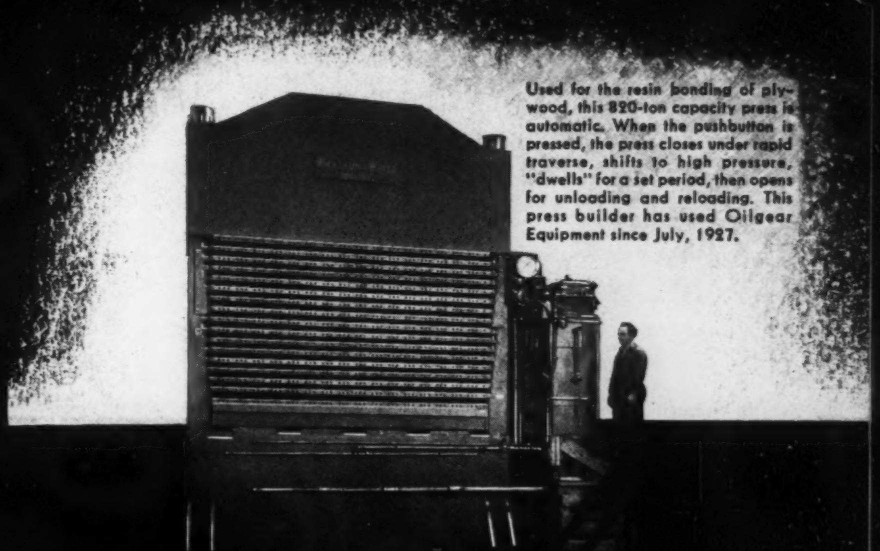
So when the designers came to the crucial point of the steel "muscles" to lift and lower this giant arm . . . the choice quickly settled on Whitney Duplex Roller Chain, with a 2" pitch. Made from tough nickel steels (like all Whitney products), Whitney Roller Chains fitted right into Y & T's design . . . and now help to keep this huge machine on the job, day after day. And *you* will find too, on your power drive problems, that Whitney Chains will fit into *your* plans . . . and fit your product or plant equipment for long, economical service. WRITE.

The WHITNEY CHAIN & Mfg. Company
Hartford, Connecticut

WHITNEY PRODUCTS

Roller Chain & Sprockets, Silent Chain & Sprockets, Conveyor Chain & Sprockets, Roller Chain Flexible Couplings, Automatic Load Limiting Sprockets, Automatic Drive Tensioners, Universal Chain Vises.

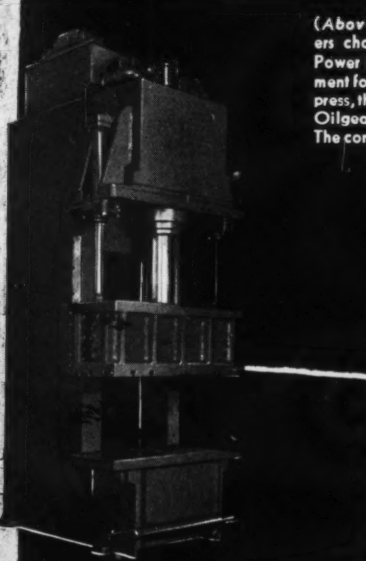




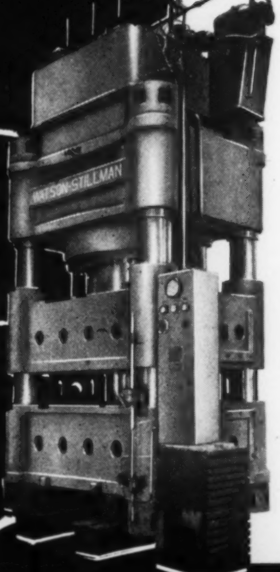
Used for the resin bonding of plywood, this 820-ton capacity press is automatic. When the pushbutton is pressed, the press closes under rapid traverse, shifts to high pressure, "dwells" for a set period, then opens for unloading and reloading. This press builder has used Oilgear Equipment since July, 1927.

WHAT 17 *leading* PRESS MANUFACTURERS ARE DOING

(*Above*) When the builders chose Oilgear Fluid Power Pumps and Equipment for this great forming press, they had been using Oilgear since June, 1931. The conclusion is obvious.



(*Above*) This press builder writes, "All our customers using Oilgear-equipped Presses are 100% satisfied with their efficiency and performance; and especially pleased with the ease of Oilgear control."



(*Above*) This 4500-ton Metal Forming Press is one of a number of recent Presses by this manufacturer employing all-Oilgear Fluid Power. This company has used Oilgear since May, 1931.

(*At left*) A Self-Contained, Semi Automatic Hot Moulding Press, capacities to 500 tons . . . employing Oilgear Fluid Power Systems. Another leading press manufacturer who uses Oilgear Equipment extensively.

17 leading manufacturers of huge production presses are using Oilgear Fluid Power Pumps and Valve Equipment, on both standard and special presses. One has equipped more than 100 presses with Oilgear; another more than 60. More recent "converts" to Oilgear Fluid Power account for 5 to 25 units each. Total figures probably represent a major portion of the business done in these giants.

The reason for this growing use *and growing preference* is clear. The application of Oilgear Fluid Power means a power problem *solved*. . . a greater measure of dependability, and protection to the user's reputation. The widely known superiority of Oilgear Fluid Power in design, engineering and performance is an asset. User satisfaction is assured. It is worth your while to read Oilgear Bulletin 47000 before you buy any more Fluid Power Equipment. Send coupon for this 56-page Fluid Power Manual *today*. THE OILGEAR COMPANY, 1310 W. Bruce St., Milwaukee, Wis.

OILGEAR

Trademark
Reg. U. S. Pat. Off.

OILGEAR

THE MOST EFFECTIVE APPLICATION OF *fluid power*

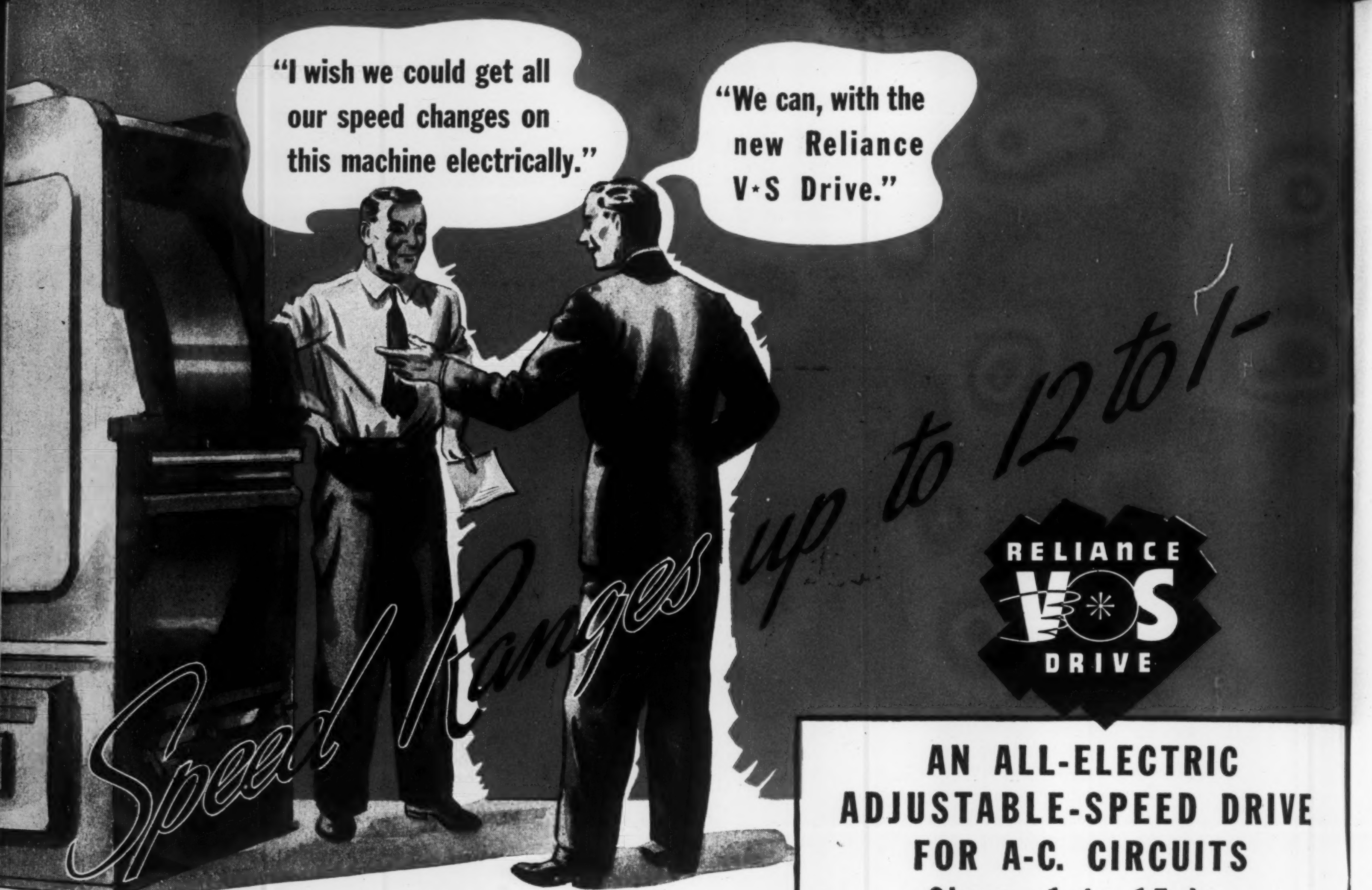
THE OILGEAR COMPANY, 1310 W. Bruce Street, Milwaukee, Wis.
Please send me a copy of Bulletin 47000 without obligation.

Name. . . . .

Company. . . . .

Address . . . .

City . . . . *State* . . . .


"I wish we could get all our speed changes on this machine electrically."
"We can, with the new Reliance V·S Drive."
Speed Ranges up to 12 to 1–
RELIANCE V·S DRIVE

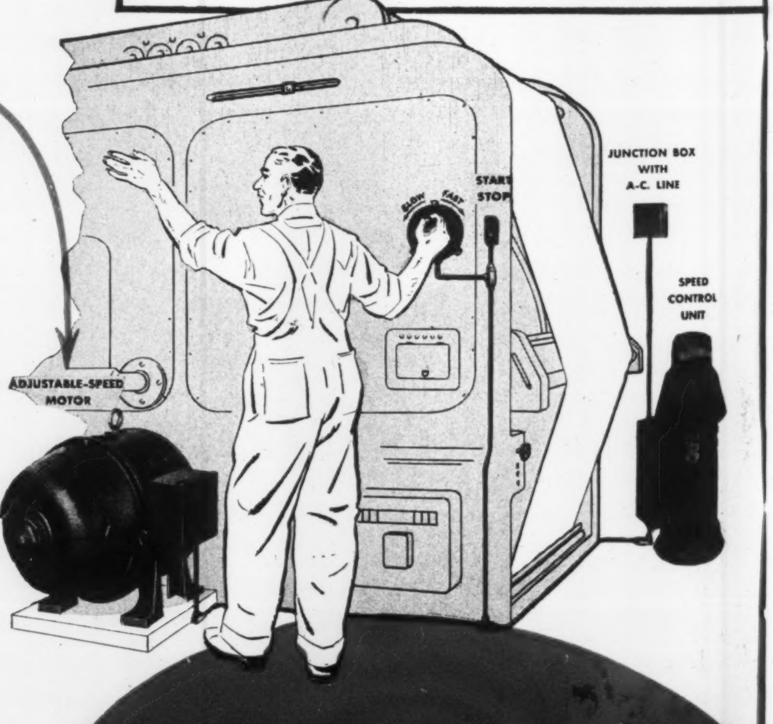
AN ALL-ELECTRIC
ADJUSTABLE-SPEED DRIVE
FOR A-C. CIRCUITS
Sizes—1 to 15 hp.

THIS new drive takes full advantage of the fact that the electric motor is not only a power unit but also provides within itself a simple method of speed changing. It enables you to get power closer to the place where power is needed and to eliminate intermediate speed-changing devices. It takes humps and bulges out of your machines—aids efficient, streamlined design.

Starting and stopping are as simple as ringing a door bell; speed changing easier than turning a doorknob. And there are no limitations on convenience. The start-stop button and speed changer can be placed anywhere that a wire can be run. Both are so compact that they can be grouped with other control elements for the machine.

And these features help production, too—quick stopping, reversing, safe speeds for threading and inching, ample starting torque with smooth acceleration, stopping and starting without interfering with the speed setting.

Ask for Bulletin 307, which gives details


ADJUSTABLE-SPEED MOTOR
SLOW
FAST
START
STOP
JUNCTION BOX WITH A-C. LINE
SPEED CONTROL UNIT

Reliance Electric & Engineering Co.
1079 Ivanhoe Road **Cleveland, Ohio**

Birmingham, Boston, Buffalo, Chicago, Cincinnati, Detroit, Greenville (S. C.), Los Angeles, New York, Philadelphia, Pittsburgh, Portland (Ore.), St. Louis, San Francisco, Syracuse (N. Y.), and other principal cities.

A Proven Principle of Speed Control

The Reliance V·S Drive employs a proven principle of speed control long used for large units. The "packaged" Speed Control Unit now makes available the smaller sizes for applications where cost has formerly prohibited their use.

RELIANCE A-C D-C MOTORS

New Thermal Switches

Compact-design ARROW H&H

MANUALLY OPERATED

LOAD-LIMIT

OVERLOAD PROTECTION
for Single Phase, 1½ H. P. Max.
or Polyphase, 2 H. P. Max.

A H&H
ON
RESET BY THROWING TO OFF
OFF
ON

Heater Element in 28 different ratings quickly installed by removing the back snap-on cover.

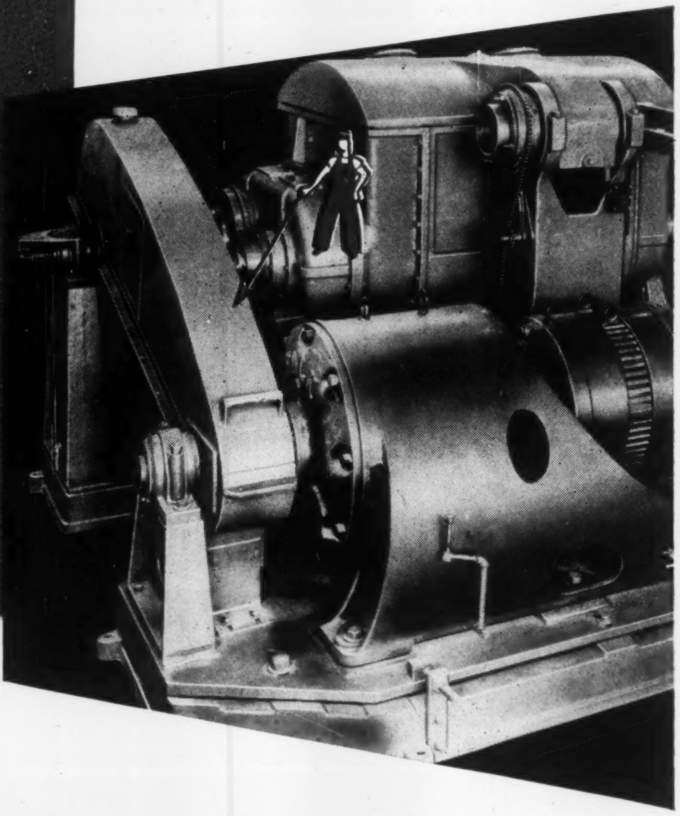
START HERE for dependable operation of your machines!—Start with a handier, smaller switch giving greater range of overload protection. . . Thermal protection for polyphase motors up to 2 H.P., 440 V., A.C. or 1½ H.P., 230 V., D.C.; for single-phase to 1½ H.P., same voltages. Interchangeable heaters—from 0.24 Amps. to 12.5 Amps.—provide 28 different ratings without special fusing. By its *wide application* in *narrow compass,* the new switch simplifies machine design and control. Fifty years of fine switch-making *does* help.

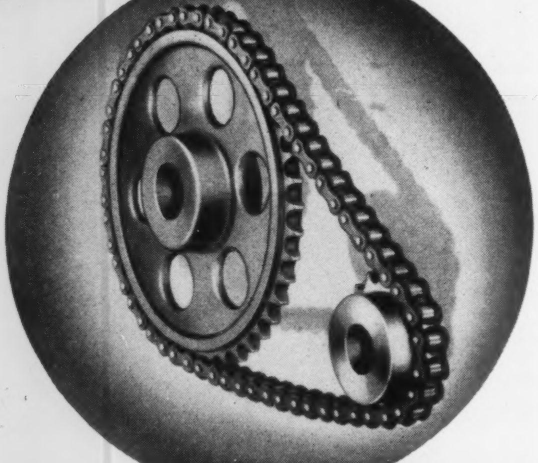
ACROSS-THE-LINE TYPE (Type L. L.), Open or Enclosed, Front-Operated, Front-Wired. Silver-plated Contacts with Knife Action. Full-floating, Self-aligning Movable Contacts, Spring-reinforced. Thermal Overload Protection by Bimetallic Action. Trip-free Mechanism: Smooth, Positive Action. Bakelite Base, Heavy-gauge Sheet-Steel Housing. . . Ask for Catalog 8-M and for free engineering counsel if desired, on *special electrical controls* for machines or appliances.

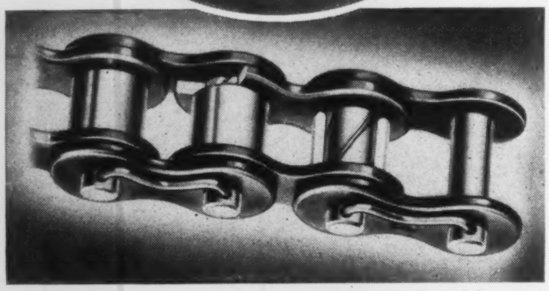
INDUSTRIAL CONTROL DIVISION, THE ARROW-HART & HEGEMAN
ELECTRIC COMPANY, HARTFORD, CONN., U.S.A.

MORSE
ROLLER CHAIN

BRINGS TO
INDUSTRY
GREATER DEPENDABILITY
CHANNEL LUBRICATION
INTERCHANGEABILITY







Cutaway view shows rolled-in channel which takes oil from rollers, through sideplates, to the pins.

Now, a roller chain that will take the hard service without complaining—and will need less service and maintenance.

It's the Morse Roller Chain—a round pin roller chain interchangeable with every other standard round pin roller chain. But there are important differences in Morse Roller Chain!

1. Exclusive design puts an oil feed system in every link, feeds oil to the pin and bearing surfaces, where wear causes most roller chain failures.
2. For greater strength and longer wear, rollers are turned from solid, hardened, special alloy bar stock.
3. Morse design permits heavier sideplates, providing the advantages of the heavy series in standard chain.
4. The Morse patented Spring Lock Pin (optional) will not shake out by vibration and will not chew.

Morse Roller Chain is available in standard and heavy series, in single and multiple widths.

Just off the press is an engineering and data book, giving complete construction and application information on the Morse Roller Chain. Ask Morse, Ithaca, or the Morse man near you for your copy of Bulletin R-54.

SILENT CHAINS   ROLLER CHAINS   FLEXIBLE COUPLINGS   KELPO CLUTCHES

MORSE *positive* DRIVES

MORSE CHAIN COMPANY ITHACA N. Y. DIVISION BORG-WARNER CORP.

This **MASTER MANUAL**

takes the mystery out of V-belt drive selection

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The MASTER MANUAL
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In three minutes

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No tricky figuring or complicated engineering calculations . . . just simple arithmetic and common sense.

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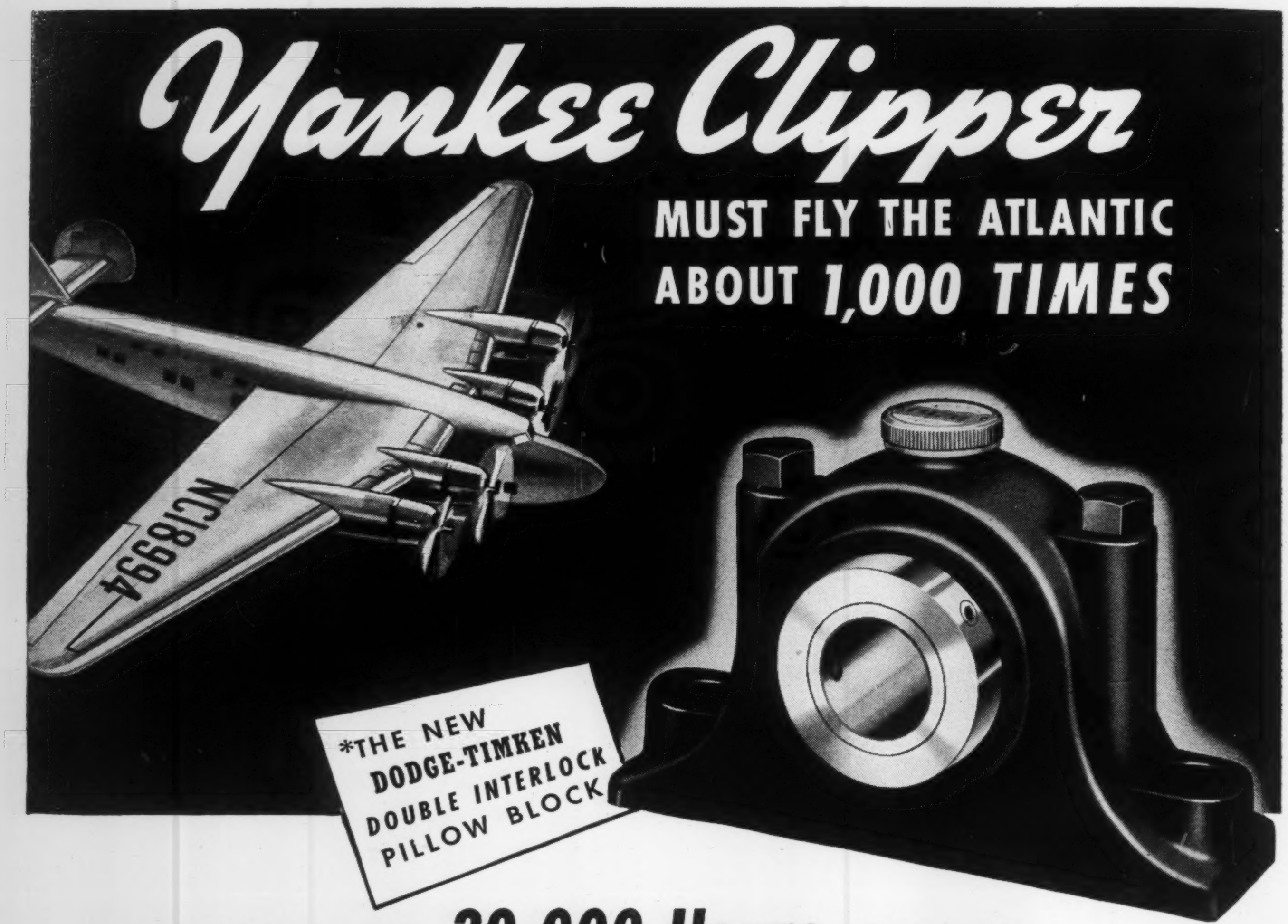
MVO-1


Yankee Clipper
MUST FLY THE ATLANTIC
ABOUT 1,000 TIMES
NC18994
*THE NEW
DODGE-TIMKEN
DOUBLE INTERLOCK
PILLOW BLOCK

TO EQUAL THE *30,000 Hours* SERVICE BUILT INTO THIS NEW DODGE-TIMKEN BEARING

Announcing
THE New DODGE-TIMKEN
★ DOUBLE INTERLOCK
ROLLER BEARING

THIS is more than the announcement of a new bearing. It is really the announcement of a complete line of Dodge Rolling Bearings offering complete coverage of industrial bearing requirements and each designed to give 30,000 hours of trouble-free service . . . The Dodge-Timken Double Interlock Pillow Block is rugged —easy to install—hermetically sealed and designed to give 30,000 hours service under conditions for which it is adapted . . . Dodge Rolling Bearings prove themselves on the basis of production profits — there is a size and type for every job — many of them are carried in local distributor stocks for immediate delivery

DODGE MANUFACTURING CORPORATION, Mishawaka, Indiana, U. S. A.

DODGE
MISHAWAKA

REAL HELP FOR YOU

The simple, conveniently arranged selection tables in this NEW Bulletin A-325 takes the guesswork out of bearing selection — send for your copy today.

***THE 30,000 HOUR LINE OF DODGE ROLLING BEARINGS**

MICRO SWITCH

If You Wish to Measure the Whisper of a Watch Tick . . . or Limit the Movement of a 5500 Ton Press . . . .

. . . . . or have any other switching problem where small size, light weight, precise operation and long life are essential, then you should investigate the application possibilities of the Micro Switch.

The Micro Switch is smaller than your thumb and weighs only one ounce. It requires energy ranging from only .004 to .0003 ounce inches, depending on the type of switch desired.

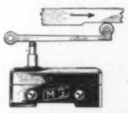
The Micro Switch meets requirements for repeated operation at a precise point. It provides positive, clean snap action *even* on slow actuation, although it *will* operate at the rate of 300 times per minute for as high as ten million trouble-free operations.

The Micro Switch is rugged, has low electric resistance, high dielectric resistance, resists vibration and requires no leveling. It is listed by the Underwriters' Laboratories with a rating of 1200 watts up to 600 volts.

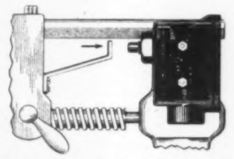
Micro Switches are used on machine tools, in aircraft, in bottling and packaging machines—wherever time, temperature, pressure, weight, relays or solenoids are involved in control.

Micro Switch engineers are skilled in the application of precision switching to many types of equipment. Present your problems to them.

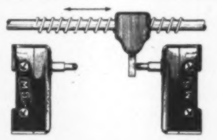
Here Are Only a Few of Thousands of Micro Switch Applications



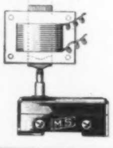
Straight Cam Control—*Cam on rod or bar actuates roller arm which operates the Micro Switch. Used on machine tools and packaging machinery to control operation.*



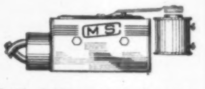
Lathe Carriage Stop—*Lathe carriage actuates the Die Cast Micro Switch at end of travel.*



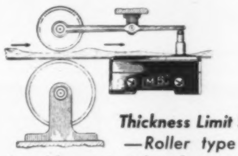
Screw Operated Carriage *actuates, at each end of travel, a Micro Switch which reverses or stops motor drive.*



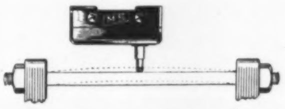
Solenoid Control—*Plunger of solenoid actuates Micro Switch to control other circuits.*



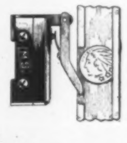
Metal-Clad Micro Switch *with snap spring actuated by magnet.*



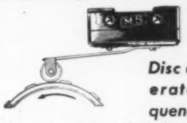
Thickness Limit Switch—*Roller type actuator rides material and operates the switch if thickness limit is exceeded.*



Stress Signal—*The rod bends under stress and actuates a spring plunger Micro Switch.*

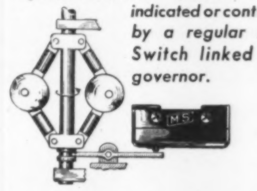


Coin Actuated—*In a coin machine, the weight of a falling coin, through a proper lever, operates a regular sensitive Micro Switch.*



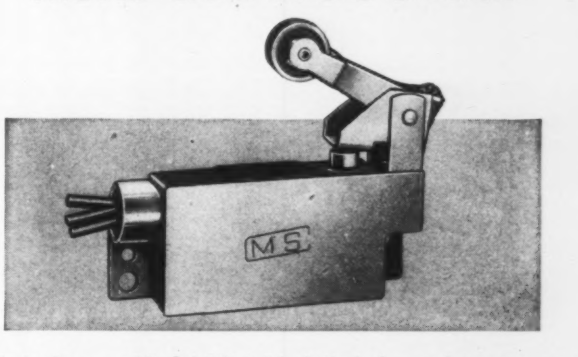
Disc and Cam Operated—*A sequence of operations is controlled by means of a roller-leaf actuator following the strips on a driven drum.*

Speed Governor Control—*Speed indicated or controlled by a regular Micro Switch linked to a governor.*



Copyright 1940, Micro Switch Corporation

A NEW Roller-Actuated Metal Clad Micro Switch



This is the new Model LK-2 Limit Switch—an improvement of the well-known and widely used LK Limit Switch. It is designed for use where rotating or sliding cams contact the roller.

. . . . The roller arm is a strong casting attached integral with the steel housing and is adjustable to any position through an arc of 225°. The roller is case hardened, concentric to .002" and rides on an oilless bronze bearing. It is fully described in Data Sheet No. 8. Write for it.

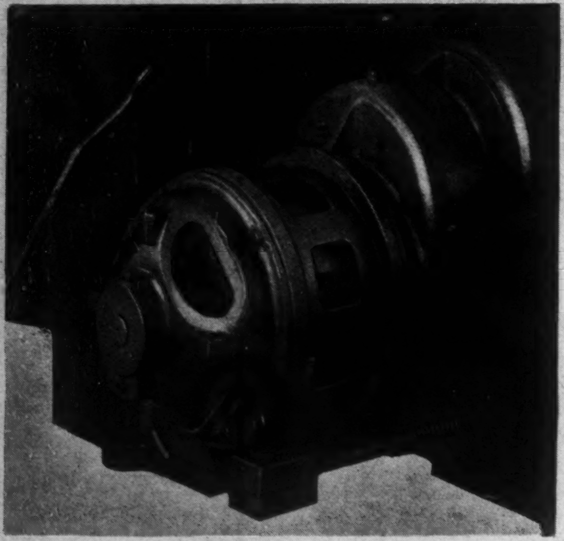
MICRO MS SWITCH

TRADE MARK

Manufactured in FREEPORT, Illinois, by Micro Switch Corporation. Sales Offices: New York, Chicago, Boston

"STOCK" DRIVES SAVE SPACE AND COST

MOTORS FOR BUILT-IN APPLICATIONS

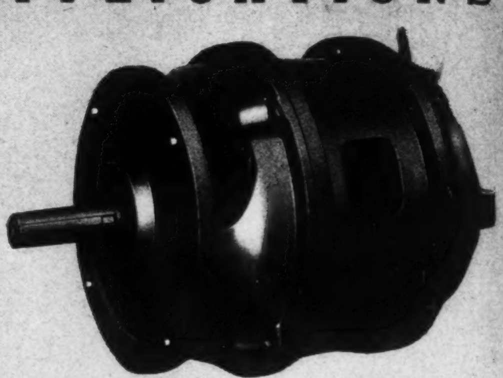


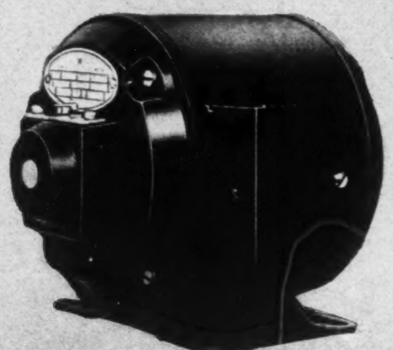
FLANGE MOUNTED GEARMOTORS

High-speed efficiency for low-speed drives—Westinghouse gearmotors. Select mounting to match requirements. Save space, add to appearance of machine, reduce maintenance costs.

FLANGE MOUNTED MOTORS

Wide variety of mountings permits selection of standard parts for assembly best fitted for the job. Can be supplied in enclosed type to seal against dust, dirt and moisture for unusually severe conditions.

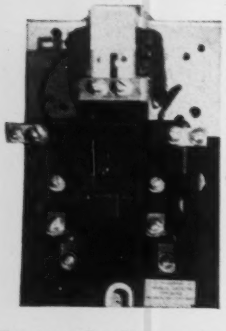


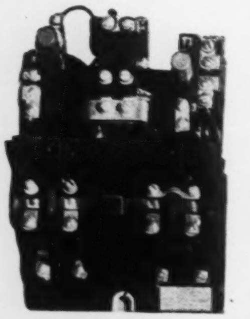


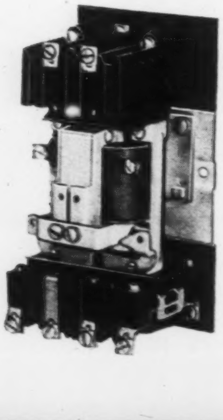
FRACTIONAL HORSE-POWER MOTORS

For any type of application requiring small motors such as auxiliary motions and cooling systems. Brothers in sturdiness, durability and dependability to large Westinghouse motors. Obtainable with sleeve or ball-type bearings. Protection against burnouts. Stock mountings to meet special requirements.

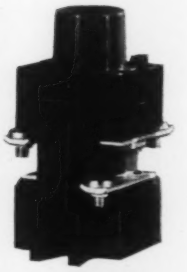
BUILT-IN MOTOR CONTROL FROM STANDARD UNITS

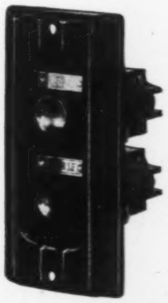






Across-the-line motor starters and contactor units, for practically all built-in applications, with motor protection and all circuit interlocking functions.



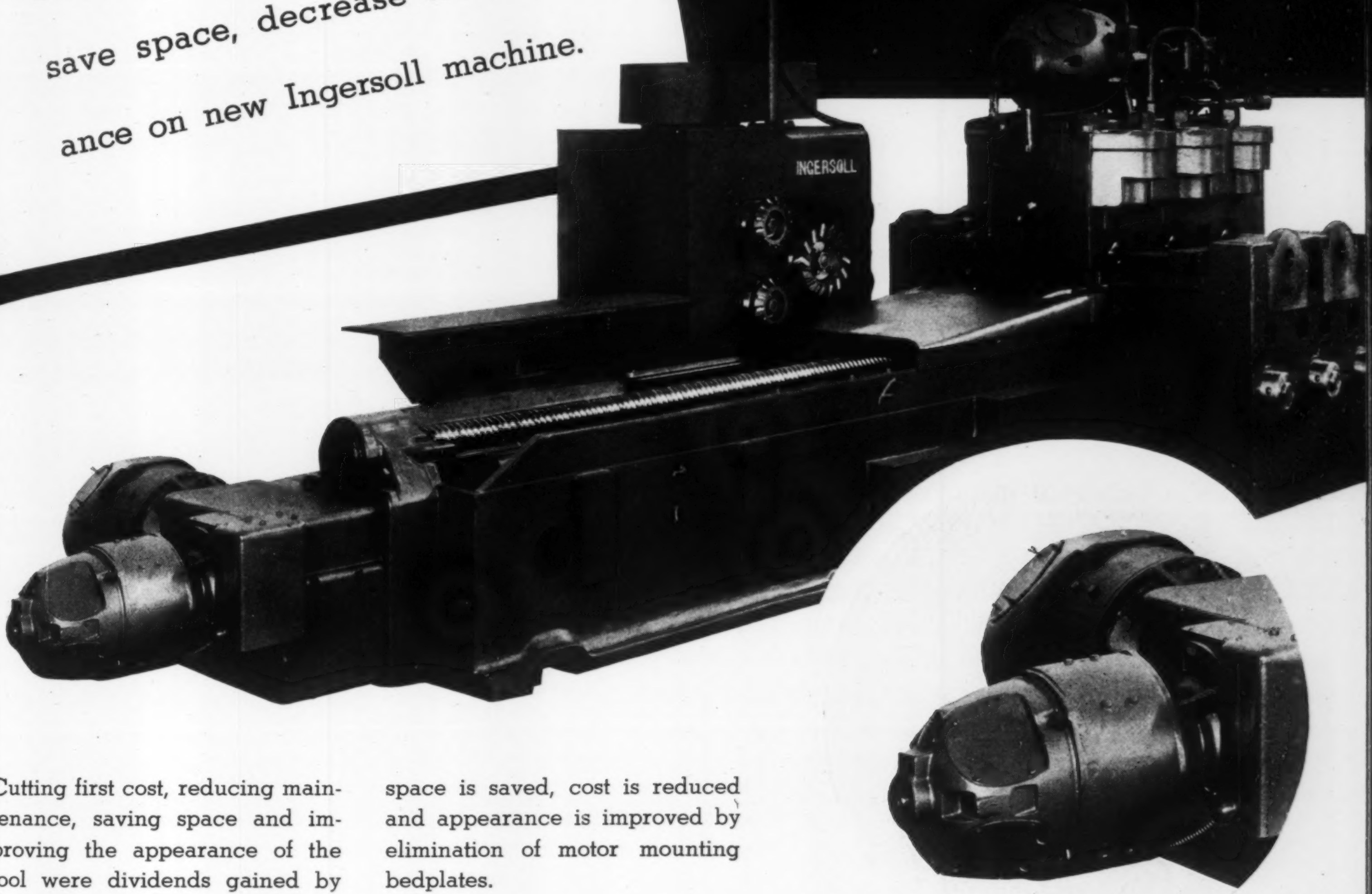


Standard push-button unit — for built-in applications, available for steel plate, surface, and flush plate mounting.

Westinghouse

WESTINGHOUSE ELECTRIC

Standard Westinghouse flange mounted motors cut initial cost, save space, decrease maintenance on new Ingersoll machine.



Cutting first cost, reducing maintenance, saving space and improving the appearance of the tool were dividends gained by The Ingersoll Milling Machine Company through the use of Westinghouse standardized drives on this copper bar scalping machine.

The differential feed box becomes a self-contained unit when equipped with flange mounted traverse and feed motors. This construction eliminates seals and bearings in the gear box since the drive pinions are directly mounted on the motor shaft extensions. With this design, floor space is saved, cost is reduced and appearance is improved by elimination of motor mounting bedplates.

The use of totally-enclosed motors, both on the feed box and for hydraulic pump drive on the carriage, insures protection from dirt and metal chips, with attendant maintenance advantages.

Our engineers are at your service for the solution of similar drive problems. Ask your local office for complete data, or write Westinghouse Electric & Manufacturing Company.

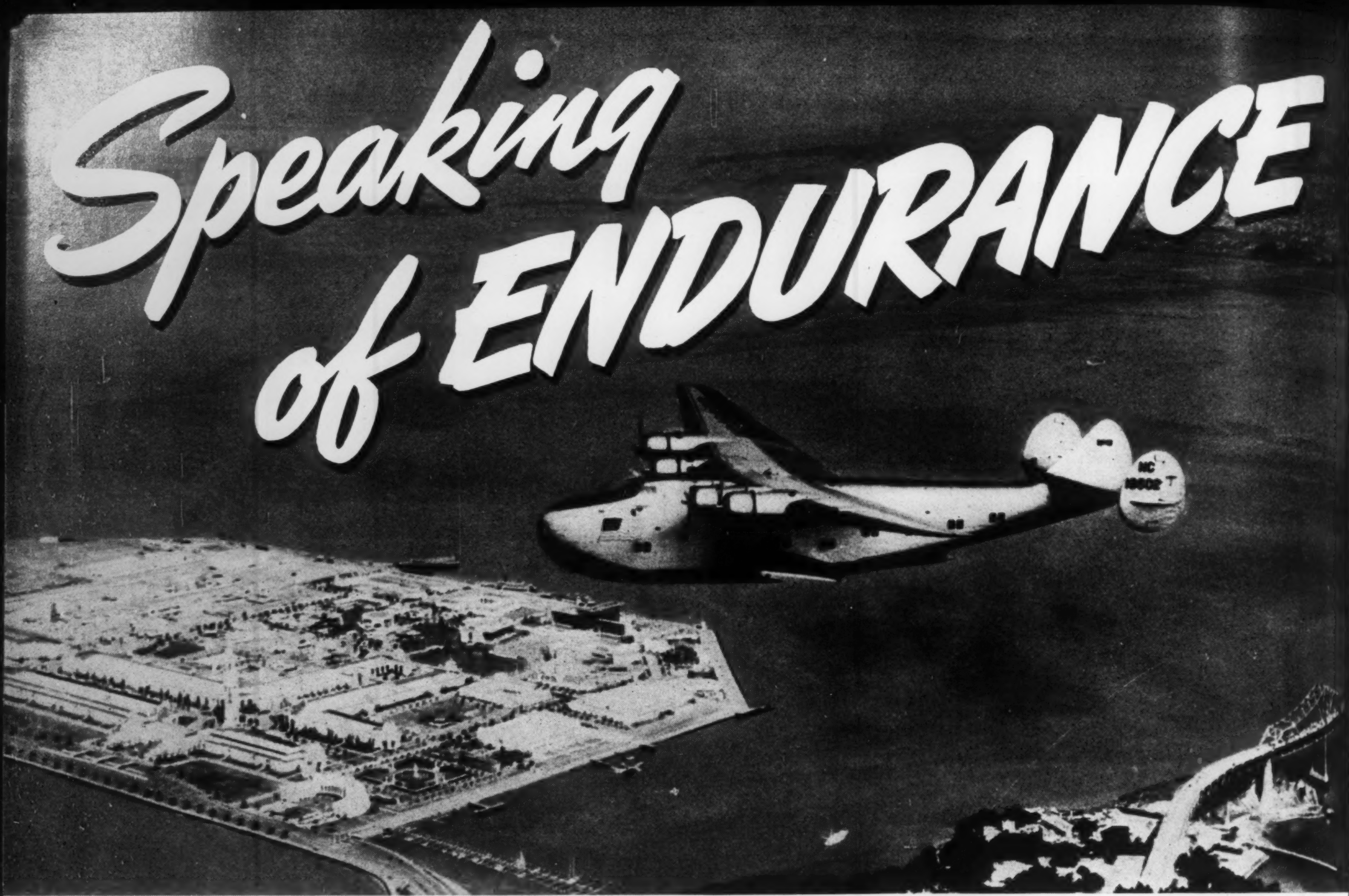
Westinghouse Standardized Drives on this machine include:

1 — 40 hp foot mounted main drive motor
1 — 7½ hp flange mounted rapid traverse motor
1 — 5 hp flange mounted feed motor
1 — 5 hp foot mounted fixture motor

J-90207

Motors and Control

Speaking of ENDURANCE



A Pan American Airways Clipper beginning a routine 2,410 mile hop across the Pacific to Hawaii. (Acme Photo.)

Trans-oceanic flying is safe largely because the planes are so designed that they seldom require more than half their available horsepower. Dumore (universal) electric motors are "safer buys" because they, too, have extra endurance built-in through many exclusive practices and highly developed manufacturing methods. Dumore motors powering business machines, appliances, delicate controls, are known for the way they carry on far beyond the life expectancy of an ordinary motor under similar conditions. Your power problem, peculiar though it may be, can be solved more satisfactorily through Dumore engineering service. Read how the aviation industry depends on Dumore; write for brochure "Speaking of Endurance."

THE DUMORE CO., Dept. 120-D. RACINE, WIS.

MORE MOTOR FOR YOUR MONEY
TRADE MARK REG.
THE DUMORE
TYPE
RACINE WISCONSIN
VOLTS
AMPS
CY
HP
SER

Dumore Motors

FOR EXTRA POWER HOURS

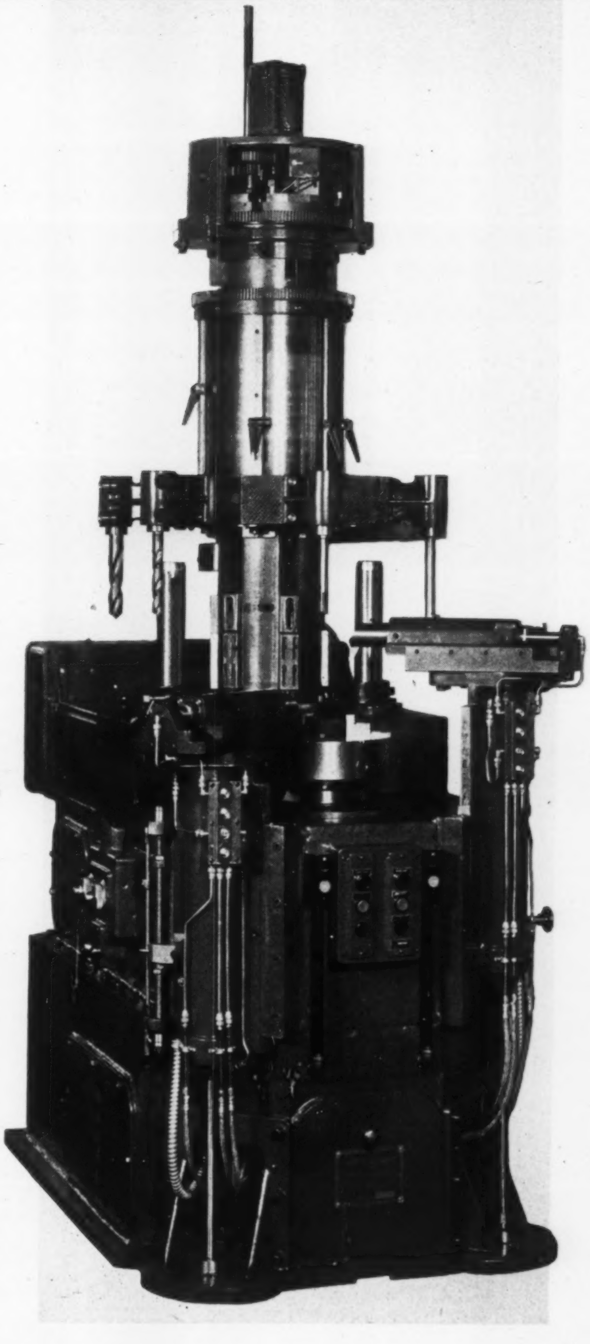
SPECIFICATIONS TYPE E1-Y AIRCRAFT MOTOR

Series reversible, 12 or 24 volts D.C.; H.P. range, 1/14 to 1/20; full-load speeds, 1,600 to 200 R.P.M.; watts input, 120; duty, 10-minute; totally enclosed; weight, 3 lbs.; all screws safety-wired. (This motor was designed and built especially for aircraft use.)

Coordinated Controls Permit Wide Range of Work

By
W. E. DeVoe*

and
R. L. Bazley*



DESPITE the complex type of work frequently expected of modern machines, the best drive and control systems often are the simplest. This fact is notable in the single spindle automatic chucking machine in *Fig.* 1. It has a six-faced turret on a rigid central column and two side heads adjacent to a central chuck, and any sequence of operations involving the turret faces or side heads may be preset. Means of co-ordinating controls and drives for eliminating one or more stations are essentially simple and logical. Eight operations are available, with a capacity of 16-inch diameter and 9-inch depth.

Built by the Production Machinery Development Co., Detroit, this machine was designed to fill the gap between the two main groups of chucking machines: Automatic, high production units, or slower manually operated machines and single purpose semiautomatics. *Figs.* 1 and 2 show front and rear views of the machine, respectively, in which drives and controls are clearly indicated.

Unit construction was adopted throughout in the interest of economy both in manufacture and maintenance. Quick removal of any unit for repairs or substitution in any emergency is possible without

Fig. 1—Front view of single spindle automatic chucking machine with six-faced turret and two independent side heads at front corners. Indexing mechanism is at top. By means of co-ordinated, essentially simple controls, any sequence of operations involving turret faces or sideheads may be preset. A total of eight operations are available

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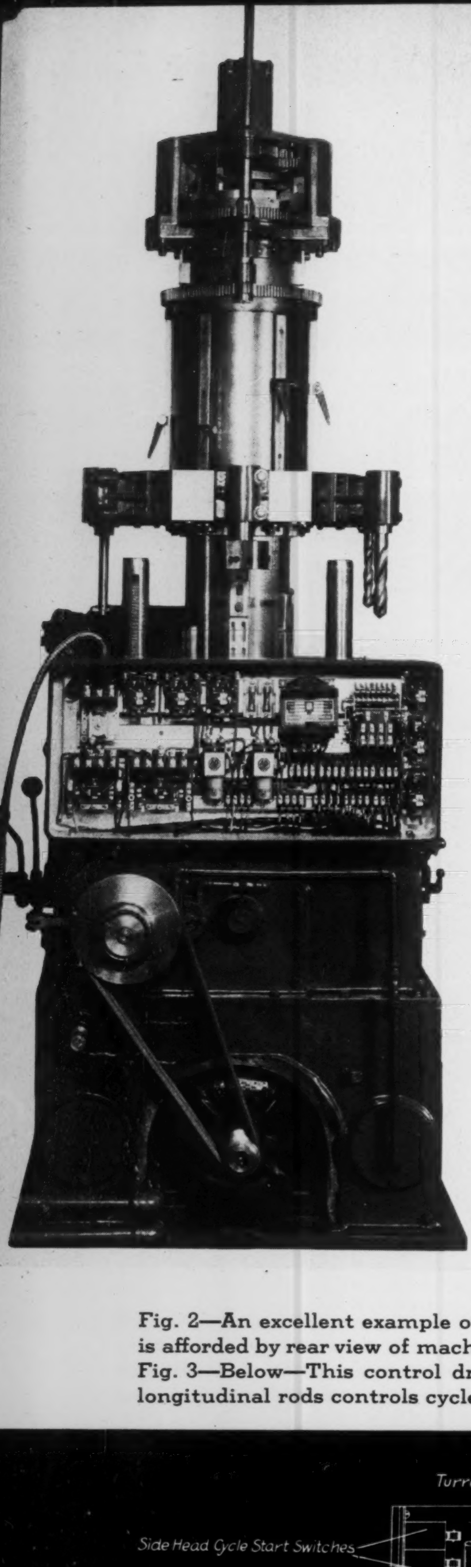
*Mr. DeVoe and Mr. Bazley are chief engineer and design engineer, respectively, Production Machinery Development Co.



dismantling the machine or disturbing unconcerned units.

Fig. 4 is a full length, cross-section of the machine with parts separately marked. Mounting the turret on a vertical column permits heavy construction and a long surface to attain rigidity, while simultaneously a minimum floor space is required. Space for the turret cylinder is provided within the heavy column, compactness is increased by top-mounting the index mechanism.

Six bronze gibs extend the length of the turret barrel and are all adjustable as a unit, providing takeup. Two widely spaced guide pins, engaging hardened bushings at the extreme diameters of the turret face, secure and maintain accurate alignment in its working position. The turret is carried on ball bearings surrounding the column and is attached to extensions from the cylinder head within the column through two diametrically opposed slots in the column.

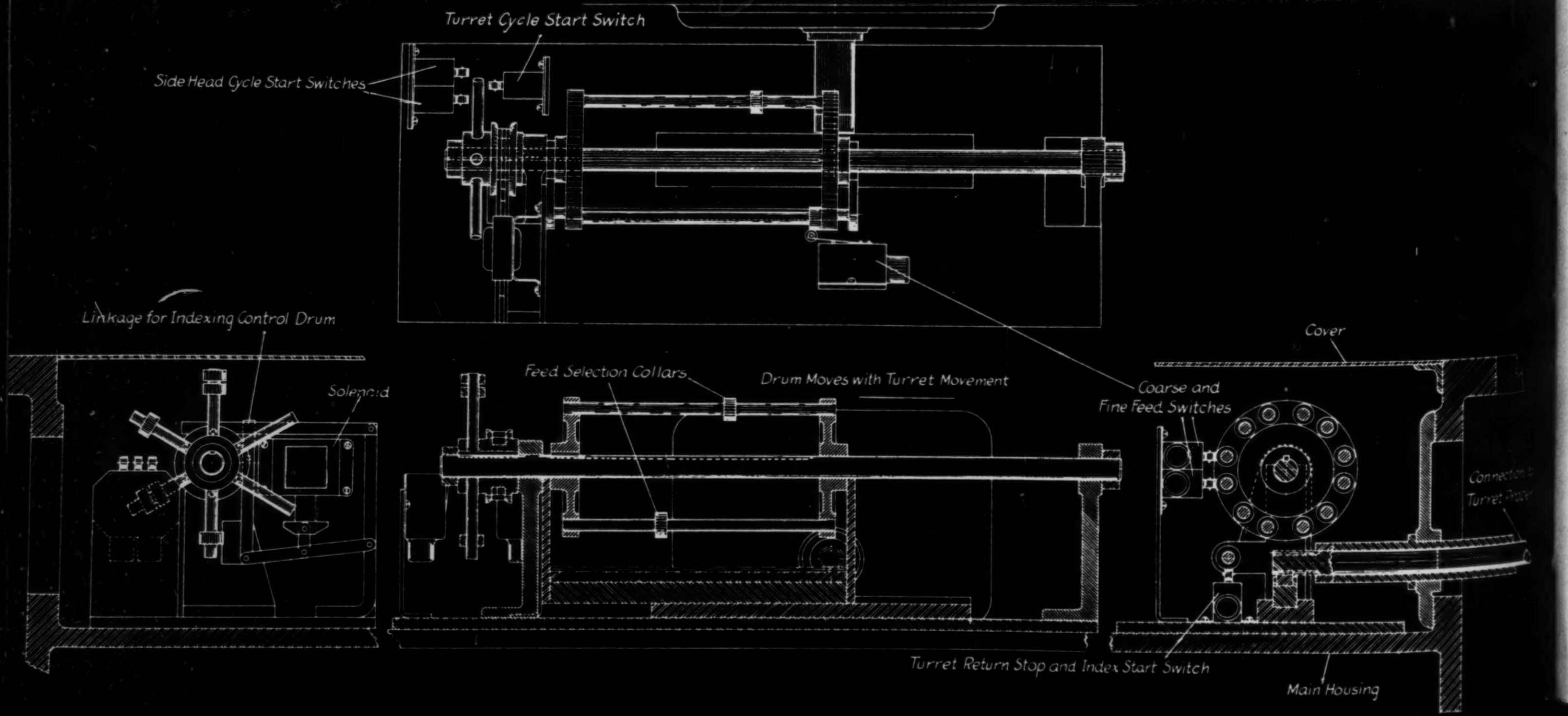
Turret Is Indexed at Any Position on Column

A ring gear, also shown in *Figs.* 1 and 2, is fitted to the top of the turret barrel and engages a pinion fixed to a splined shaft. This shaft extends through the indexing mechanism and provides a means for indexing the turret at any position on the column. Turret faces are arranged for the attachment of standard tool holders and also have T-slots for attachment of special tools. Adjustable stop blocks are placed at the base of the column to provide accurate and positive limits to the tool travel for each face of the turret.

The indexing mechanism at the top of the column is driven by a separate motor. An internal Geneva gear arrangement was designed to give easy acceleration and deceleration during indexing. A short indexing period was desirable and this indicated a motor of high starting torque and of small size to reduce rotor inertia and resultant over-run. To meet this requirement, a special motor of nominal ¼-horsepower size was designed which will develop 1 horsepower for ten minutes. This fact permitted the index period to be set at two seconds.

The turret cycle is rapid advance to work, coarse feed or fine feed or through each in sequence if desired, positive stop and dwell for clean-up and rapid return to starting position and index. This sequence may be continued for the six faces of the turret. Should a set-up not require six turret operations, one or more stations may be eliminated as follows: Each of the six lobes of the indexing gear carries a small cylindrical projection or lug which is loosely mounted on a dowel. These lugs pass and operate a switch controlling the index motor. When all are in place, the motor circuit is interrupted at each index and is not restored until a turret cycle is completed. Removal

Fig. 2—An excellent example of centralization of controls is afforded by rear view of machine showing control panel. Fig. 3—Below—This control drum formed by six pairs of longitudinal rods controls cycles of turret and side heads


Turret Cycle Start Switch
Side Head Cycle Start Switches
Linkage for Indexing Control Drum
Solenoid
Feed Selection Collars
Drum Moves with Turret Movement
Cover
Coarse and Fine Feed Switches
Connection to Turret Proper
Turret Return Stop and Index Start Switch
Main Housing

of one or more permits the indexing to continue past the corresponding faces.

Side head cycles are the same but with an added feature. When the side heads are not operating, the tools remain withdrawn from their cutting depth at any predetermined distance. At the start of the cycle the tool is first brought to the cutting depth and is rapidly advanced to the work. It is fed at a selected rate through the cut with positive stop and dwell for clean-up, followed by withdrawal of the tool from the cutting plane and rapid return to the original position.

Control of the cycles of the turret and side heads is accomplished in the simple and novel manner shown by *Fig.* 3. A cage or drum, formed by six pairs of longitudinal rods, is splined to a shaft and is slidable axially between bearings. By means of a mechanical connection, all vertical movements of the turret are reproduced in the axial movement of this drum. Two switches, controlling feed selection solenoid valves are mounted at the side of the drum and are operated

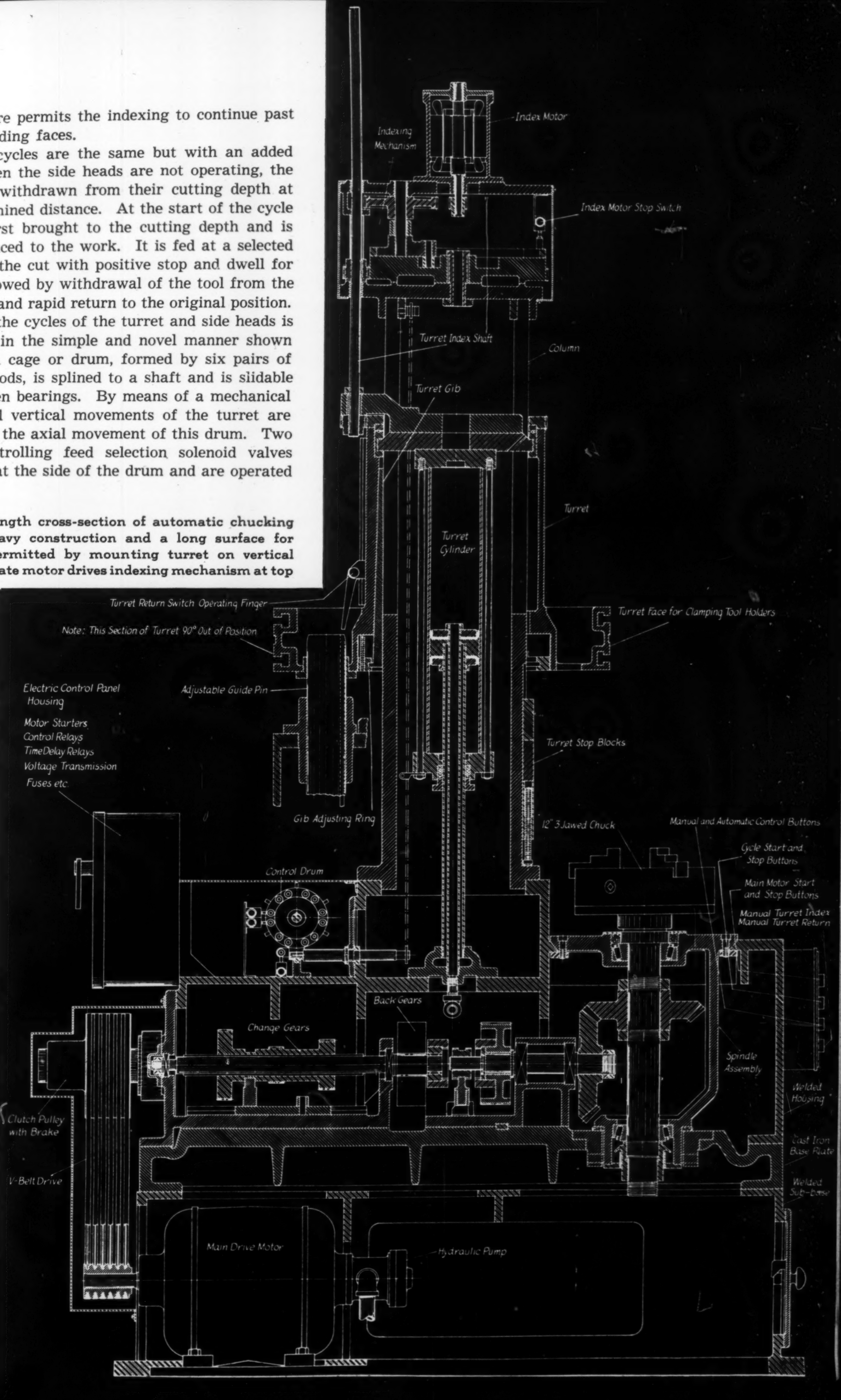


Fig. 4—Full length cross-section of automatic chucking machine. Heavy construction and a long surface for rigidity are permitted by mounting turret on vertical column. Separate motor drives indexing mechanism at top

Index Motor
Indexing Mechanism
Index Motor Stop Switch
Turret Index Shaft
Column
Turret Gib
Turret
Turret Cylinder
Turret Return Switch Operating Finger
Note: This Section of Turret 90° Out of Position
Turret Face for Clamping Tool Holders
Electric Control Panel Housing
Motor Starters
Control Relays
Time Delay Relays
Voltage Transmission
Fuses etc.
Adjustable Guide Pin
Turret Stop Blocks
Gib Adjusting Ring
12" 3 Jawed Chuck
Manual and Automatic Control Buttons
Cycle Start and Stop Buttons
Main Motor Start and Stop Buttons
Manual Turret Index
Manual Turret Return
Control Drum
Back Gears
Change Gears
Spindle Assembly
Welded Housing
Cast Iron Base Plate
Welded Sub-base
Clutch Pulley with Brake
V-Belt Drive
Main Drive Motor
Hydraulic Pump

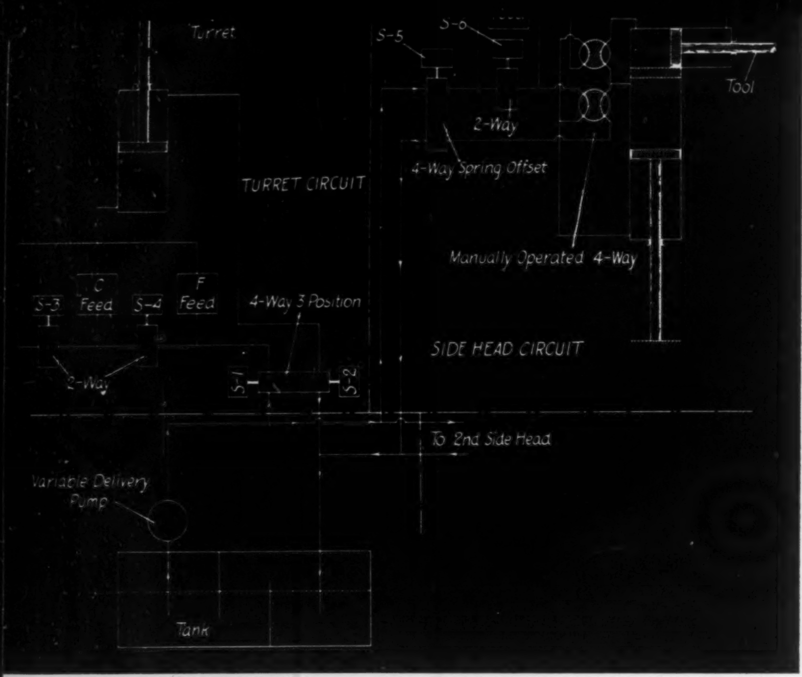


Fig. 5—This hydraulic system is controlled electrically and actuates all movements of the turret and side heads except indexing. It was selected for its simplicity after several other circuits had been tried and discarded

by adjustable cams on the longitudinal rods. The setting of these cams determines the position in the downward travel of the turret for the feeds.

The splined shaft carrying the control drum is fixed axially but is rotatable, and an extended portion carries a hub arranged for ratchet rotation. A solenoid sets the ratchet and when de-energized, the shaft and drum rotate 60 degrees. The hub also carries six radial arms which rotate between three switches, one governing the start of the turret cycle and each of the others the start of a side head cycle. Collars set on these arms operate the switches as they pass them.

In operation, the cycle start button at the front of the machine is depressed. This operates the solenoid valve controlling the downward motion of the turret. As it continues in rapid advance, the control drum is moved axially on its splined shaft and the cams on the lower pair of rods operate the switches controlling the coarse and fine feeds at the predetermined points. A return switch, operating a time delay relay, is closed by the turret at the end of its movement. This time delay permits shoulder clean-up before the withdrawal of the tool.

Solenoids Control Indexing

As the turret reaches its upper position on return, the control drum moving with it closes the return valve, starts the index motor and energizes the indexing solenoid of the control drum. When the indexing gear has made a 60-degree advance, the index motor is stopped and the solenoid at the control drum is de-energized and the drum advanced one-sixth revolution. During this angular advance, one of the radial arms extending from the ratchet hub passes between the cycle control switches mentioned above. If the collars are adjusted on this arm in register with these switches, the entire cycles will be set up. Thus it is possible to bring either or both side heads into action at any turret face regardless of whether that face is used.

While the entire cycle of the turret is controlled by this drum, the side heads depend on it only for the start of the cycle. Each has a self-contained control which continues the operation and is not affected by any turret operation. Thus the heads are not required to complete their cycle with the turret.

Numerous safety interlocks are provided to prevent damage to the machine from accident or carelessness. The entire control circuit is inoperative when the spindle drive clutch is disengaged. This prevents accidental damage to tools through contact with stationary work. The main motor drive cannot be started with the clutch engaged. Should the machine be stopped during the course of operation it cannot be started again unless the clutch is disengaged. Starting the main drive motor automatically returns the tools to starting position. These interlocks make it impossible to start the machine under load or with the tools in the cut. All circuits are so interlocked that each cycle is dependent on the one preceding. Should any cycle fail the machine is stopped automatically. A switch is provided to cut out automatic operation and permit manual control.

Side Heads at Front Corners

The side heads are located at the front corners and as far to the side as possible without interfering with the turret tools. They are placed close to the spindle to reduce the overhang of tools on small diameter work. Internal cylinders in both the cross head and the vertical slide permit cuts in either plane. This construction also gives compactness and eliminates exposed pipes and fittings. The sections resulting from the internal cylinders together with the heavy V-slides and adjustable gibs give extreme rigidity.

No particular difficulties were encountered in the transmission and no new features were attempted. Gears are alloy steel, heat treated, ground and lapped. Change gears and back gears are mounted in separate housings which can be removed through openings in the main housing without dismantling the machine. Nine change gears, arranged in clusters of three, with the back gears requiring only two shift levers for the resultant 18 speeds. The original transmission for speeds from 10 to 1750 revolutions per minute functioned satisfactorily but subsequent analysis indicated that parts requiring such high speeds were too small to be economically produced on a machine of this size and the transmission was redesigned for a speed range from 10 to 900 revolutions per minute. V-belts

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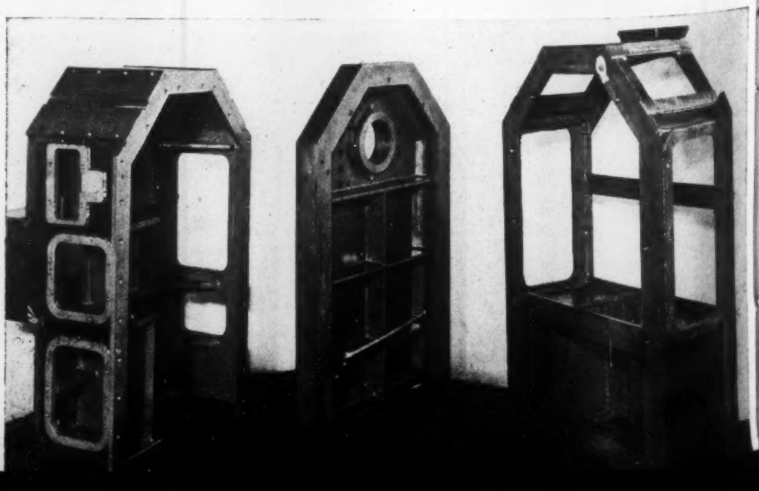
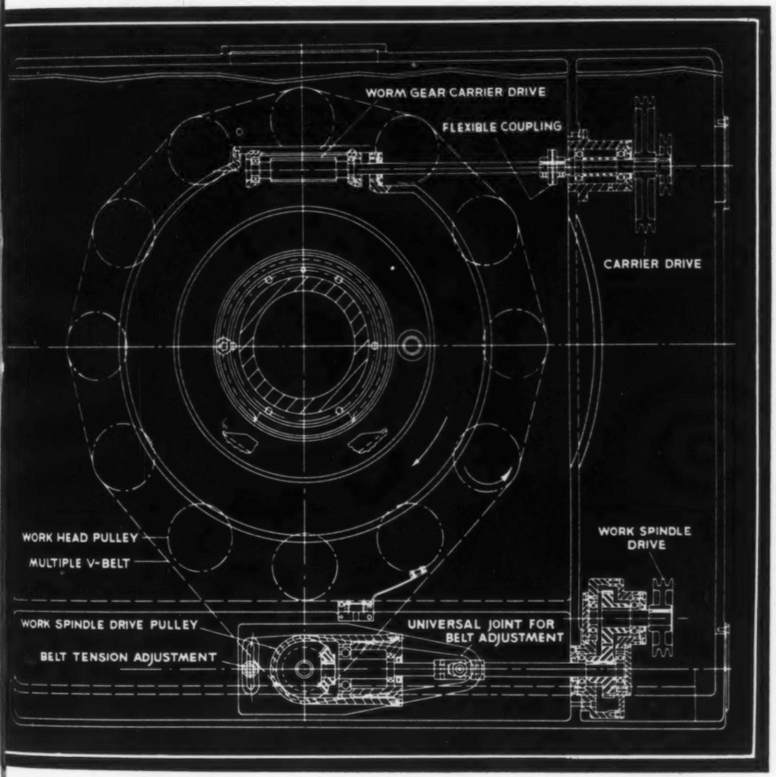
Fig. 6—The three main sections of the machine are standing here on end. Center section is cast iron, other two welded steel. Fig. 4 clearly shows assembly



Ingenious Design Simplifies Drive

By L. D. Tyson
Chief Engineer
Foster Machine Co.

IN SELECTING a work spindle drive for the Twelve Station Superfinisher, a number of factors had to be considered. There are twelve spindles to be driven intermittently but also in a continuous sequence as each spindle successively, by the continuous rotation of the work head carrier, passes through the working, and also the idle or reloading portions of each revolution of the carrier.



THIS and the following discussions of drive methods are interesting because in the design of every machine similar problems are present. Their solutions illustrate how, through ingenious design, many parts have been eliminated, performance improved, vibration reduced, new principles applied. Only by analyzing all available methods is it possible to determine the best drive for a given problem

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Belts without the use of numerous idlers are limited to a very small arc of contact, see drawing, and in case of flat belts would require an excessive tension to provide the necessary power and consequently an undue bearing load.

By the use of multiple V-belts a common drive pulley and set of belts can be used to drive all spindles. Sufficient power in this way can be transmitted without an excessive number of belts or excessive tension, and without the use of idlers, in spite of the small arc of contact.

With this arrangement, the necessity of clutches and mechanisms was eliminated as the driven pulleys successively leave the drive belts, come in contact with a brake member and after passing the reloading portion of the machine again come in contact with the drive belts, thus providing their own clutch action. The shafts being vertical, the V-belts are especially adapted to stay on the sheaves without auxiliary guides.

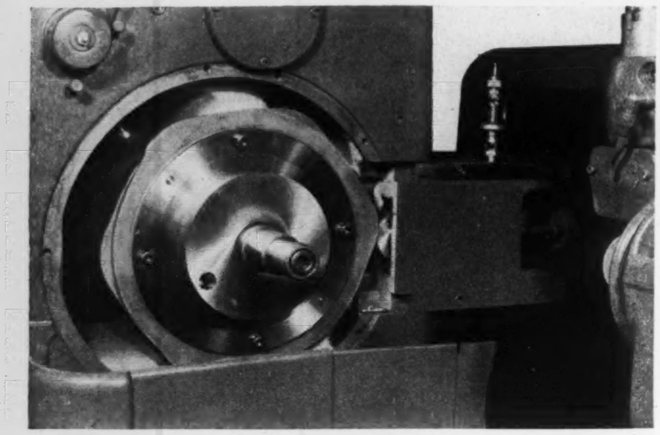
Thus, in this case, multiple V-belts make a practical drive with a minimum number of working parts, while almost any other method would have required much more extensive and more complicated mechanism, which not only adds to the initial construction cost, but also is continually reflected in maintenance.

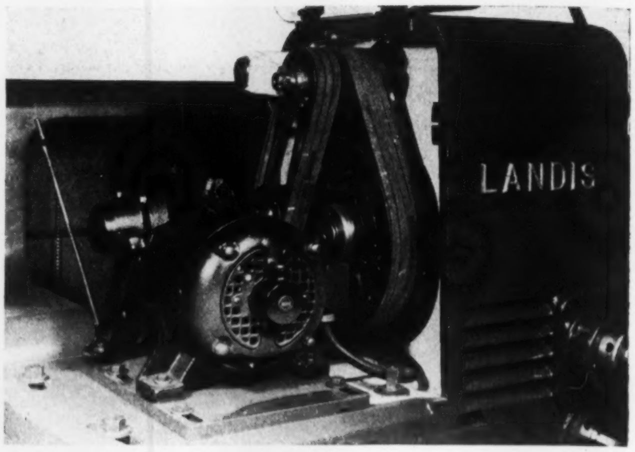
Drives Combine for Compactness

By R. S. Elberty
Electrical Engineer
Landis Tool Co.

IN GRINDING large diameter radial cams, the work must be rotated and also moved in relation to the grinding wheel so that the proper cam contour may be ground. Low speed and vibrationless operation are necessary to obtain the fine finish required. The work drive for the radial cam grinder, see illustration, is mounted in a cradle which is rocked by the action of a master cam and roller, the cradle and master cam being securely held against the roller by means of a strong spring. To prevent overhauling or back-lash, a mechanical brake maintains a load on the drive at all times.

An adjustable slow speed direct-current motor with integral worm gear reduction furnishes power the work drive. The motor is mounted on the rigid part of the headstock and drives through V-belts, shown in illustration to a jackshaft located at the center of oscillation of the cradle. A small pulley on the jackshaft drives the large work drive pulley mounted on the cradle through an additional V-belt reduction. A final speed as low as 1 revolution per minute is obtained and the entire drive is unusually compact. Smooth operation is obtained by the worm gearing and V-belt drives. Any slight motor vibration is at right angles to the plane of work rotation. Rotating members are mounted in ball bearings heavily preloaded to maintain machine rigidity.





Quick Acting Drive Is Pneumatic

By B. P. Baker
Circuit Breaker Design Engineer
Westinghouse Electric & Mfg. Co.

SWITCHING electrical circuits requires high speed, quickly responsive, mechanical operation of certain current carrying members, commonly called contacts. In large and higher power circuit breakers these contacts are frequently massive and require large forces to obtain high accelerations. These operating forces have in the past generally been obtained from electromagnetic solenoids. The magnetic force is used to close the contacts and charge a spring, which in turn supplies the opening force in response to releasing a latch.

In some cases compressed air acting on a piston has been used to replace the magnetic solenoid, in which case the air pressure acting upon the piston closes the contacts and charges a spring which when released by a suitable trigger again opens the contacts. Both the magnetic and this type of pneumatic device utilize a trip-free lever. Such a lever is attached to the opening spring and contact and latched to the piston or solenoid, so that when high-speed opening is required to follow immediately after the closing operation, the trigger is released and the opening operation takes place independent of the motion of the piston or solenoid.

These complications are eliminated in the unique springless, triggerless, pneumatic operating mechanism illustrated. The contacts are operated by air pressure, high-speed motion in both directions is obtained and the decelerating shock at the end of the travel is reduced to a minimum by the proper control of air on both sides of a single piston. Upon opening of the contacts the arc thus drawn is extinguished by the flow of air from the tank through the supporting tube and blast valve at the base of the tube. This valve is opened and closed mechanically by a bell-crank, which in turn is operated by a cam attached to the pneumatic mechanism.

To close the breaker air is admitted from the auxiliary closing chamber through the closing valve to the under side of the piston which moves it upward. Conversely, to open the breaker air is admitted to the upper side of the piston which moves it downward.

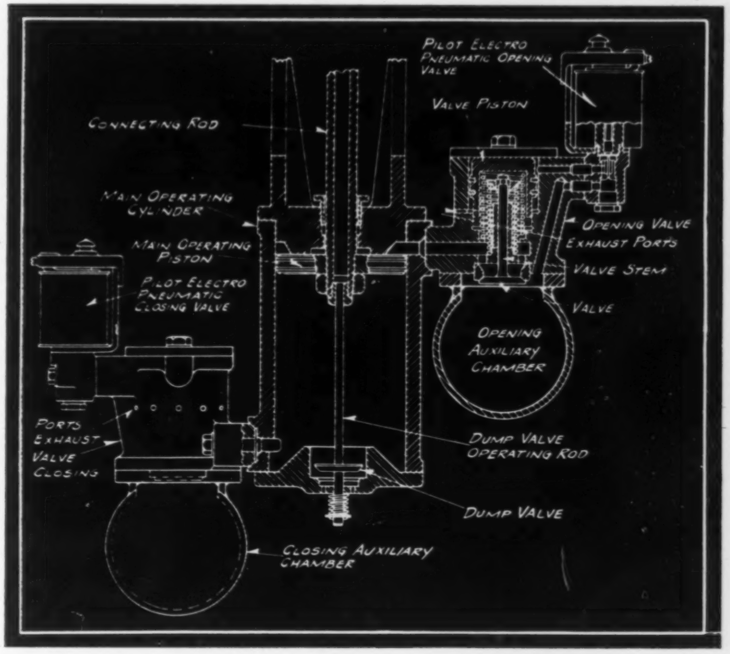
Accelerating Force Is Controlled

The volume of each of the auxiliary chambers is adjusted to some suitable percentage of the volume of the operating cylinder and communicates with the main pressure storage tank through a small hole of such size that it can charge an auxiliary chamber to full tank pressure in approximately one second. However, the amount of air that can flow through it during the small fraction of a second that it takes the piston to move from one end of the cylinder to the other is negligible. Thus, for instance, if the volume of the opening auxiliary chamber is one-half the volume of the operating cylinder, the pressure on the piston at the end of its travel will be one-third the pressure at the beginning of its motion. By this means it is possible to obtain an accelerating force of approximately 3000 pounds at the beginning of motion and reduce this force to any predetermined value toward the end. The motion resulting from this type of force is desirable in that it is important to obtain sufficient contact separation as soon as possible and then start decelerating to eliminate shock from sudden changes in motion.

Valves controlling the flow of air from the auxiliary chambers to the cylinder are pneumatically operated by electro-pneumatic valves shown. Operation is obtained by admitting a small amount of air from the auxiliary chambers through the electro-pneumatic pilot valve to the upper side of the piston of the control valve. The first ⅛-inch of motion causes the valve piston to close the exhaust ports and engage the valve stem. Any further motion opens the valve admitting air to the upper side of the main operating piston. As previously pointed out the piston is forced downward by a decreasing force due to the limited volume of the auxiliary chamber. As the piston moves down air is compressed below the piston and allowed to escape only through the ports of the closing valve. Thus by regulating the volume of the opening auxiliary chamber and the area of the port openings in the closing valve, the opening motion of the main piston can be accurately controlled and finally arrested without shock.

Conversely, the closing motion can be contracted by the closing auxiliary chamber and the ports in the opening valve.

If, however, it is necessary to open the breaker immediately (in say one-tenth of a second after closing), the air below the piston which was used to close the breaker must be eliminated if it is not to impede or interfere with the opening motion. To take care of this a dump valve is built into the lower end of the main cylinder and actuated by a rod attached in a sliding manner to the main connecting rod and adjusted to open the dump valve during the last ¾-inch of the motion of the piston toward closed position. This insures first, that the breaker will be forced completely to the over-toggle closed position before losing its driving force, and second that the pressure below the piston will be reduced to substantially atmospheric pressure before the downward or opening motion begins. In this way the opening motion is independent of the time the breaker has remained in the closed position.


PILOT ELECTRO PNEUMATIC OPENING VALVE
VALVE PISTON
CONNECTING ROD
MAIN OPERATING CYLINDER
MAIN OPERATING PISTON
PILOT ELECTRO PNEUMATIC CLOSING VALVE
OPENING VALVE EXHAUST PORTS
VALVE STEM
VALVE
OPENING AUXILIARY CHAMBER
PORTS EXHAUST VALVE CLOSING
DUMP VALVE OPERATING ROD
DUMP VALVE
CLOSING AUXILIARY CHAMBER

Thus the operating characteristics are the same for either straight opening or high speed closing-opening operation. It is accomplished without latches, springs, or trip-free levers.

Clutch Reduces Starting Torque

By R. M. Scott
Chief Engineer
New England Butt Co.

ECONOMICAL operation of a knitting loom, the load of which is essentially reciprocating, requires a low starting torque, that is, the load be accelerated slowly and a fly wheel effect be provided to give a smooth running machine. In order that a loom be operated at its most economical speed for any given pattern design, and type of yarn, a variable speed drive is also required.

A drive incorporating these requirements has been worked into the design of our new knitting loom. The power for this loom drive is taken from a ¾-horsepower, 1800 revolutions per minute, 3-phase motor. The motor drives a jack or intermediate shaft by means of a single V-belt and sheaves. Two V-belts transfer the power from the jack shaft to the clutch pulley mounted on the drive shaft of the loom. This jack shaft is used only for speed reduction purposes.

In the design of the clutch pulley, all of the drive requirements of this machine were incorporated, with the exception of speed variation. Referring to the section drawing, a clutch drum plate on the drive shaft of the machine is held in place by means of key and set screws. This plate is the driven member of the clutch assembly. The driver or clutch pulley revolves freely on the hub of the drum plate. A small bronze thrust washer between the two takes

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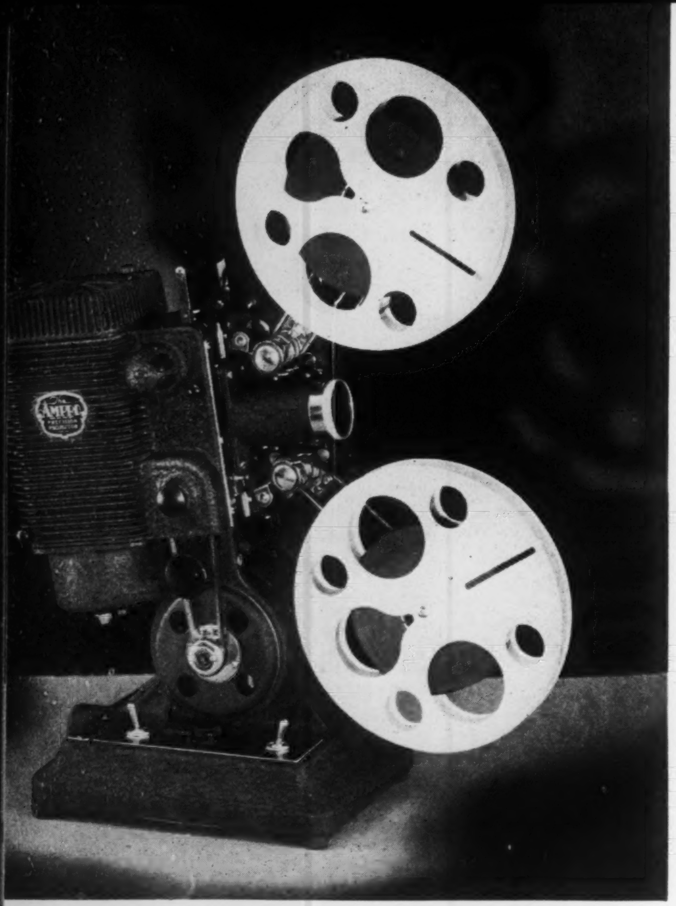
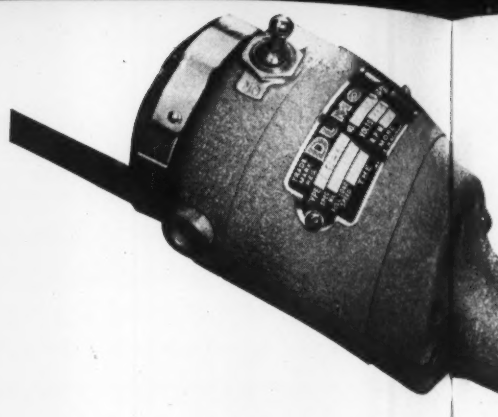


Fig. 1—Light weight and readily controllable speeds are required of motion picture projectors



When To Use Series Motors to

By W. H. Fromm

The Dumore Co.

AMONG the countless applications requiring fractional horsepower motors there are many to which the characteristics of the series-wound motor are ideally suited. Some, to be sure, demand split phase, shaded pole, repulsion or capacitor induction or synchronous motors. Refrigerators, most types of oil burners and domestic fans, for example, are best and most economically powered by induction motors. The electric clock and other timing devices are made possible principally because of the synchronous motor.

Hundreds of machines and appliances, however, require the advantages which only the series motor possesses. Among the commonest of them are included domestic vacuum cleaners, portable electric drills, fountain beverage mixers. They would be impractical without the high speed and light weight of the series motor. There are many other applications where the use of this type of power unit is not so clearly indicated, and it is the purpose of this article to discuss the factors involved in its selection.

By way of defining our subject, let us consider briefly the nature of the series motor. It has, of course, a wound rotor, or armature, and a wound stator, or field. The field coils are connected in series with the armature by means of carbon brushes which ride on a commutator mounted on the armature shaft. Hence, the same current flows in both armature and field and therefore the field flux and armature current are always in phase, regardless of reversals of polarity. This feature makes possible the operation of the motor on both alternating and direct current, and it is commonly called the "universal" motor.*

In performance the series motor is unique, having what is known as a varying speed characteristic. Roughly, the speed is inversely proportional to the load. This fact will be understood when it is realized that as the torque required decreases the current drawn by the motor also decreases, and since field flux is proportional to current and speed is inversely proportional to flux the speed rises. Similarly, when the torque requirement increases the speed drops. From this it will be seen

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*The series motor, however, is not universal when wound for voltages below 32 on a.c. The inductive reactance becomes so great in relation to the impressed voltage that the torque developed is negligible.

Performance characteristics of $\frac{1}{2}$-horsepower direct-current motor and $\frac{1}{3}$-horsepower alternating-current motor, continuous duty

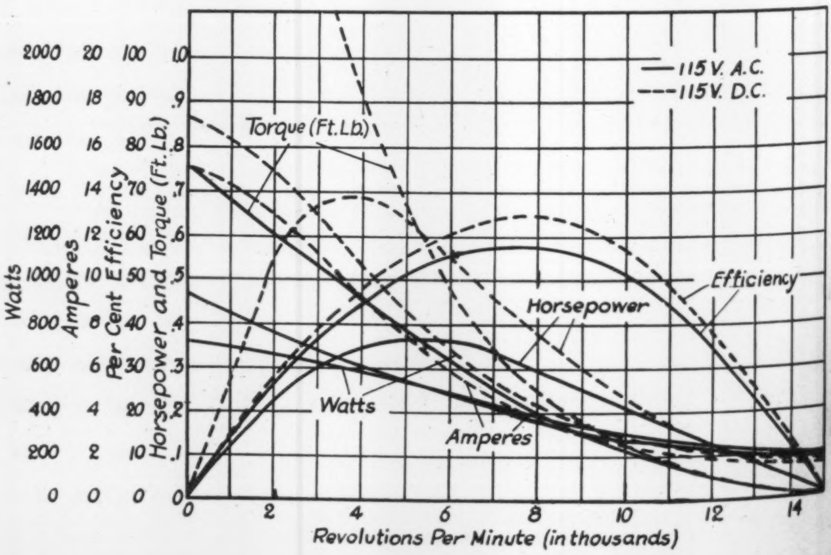


Fig. 2—Series motor supplies high spindle speeds for hand grinder at left. Light weight and universality are also features

Fig. 4—High speed routers, right, utilize series motors because of light weight and ability to operate with different power supplies

s to Advantage

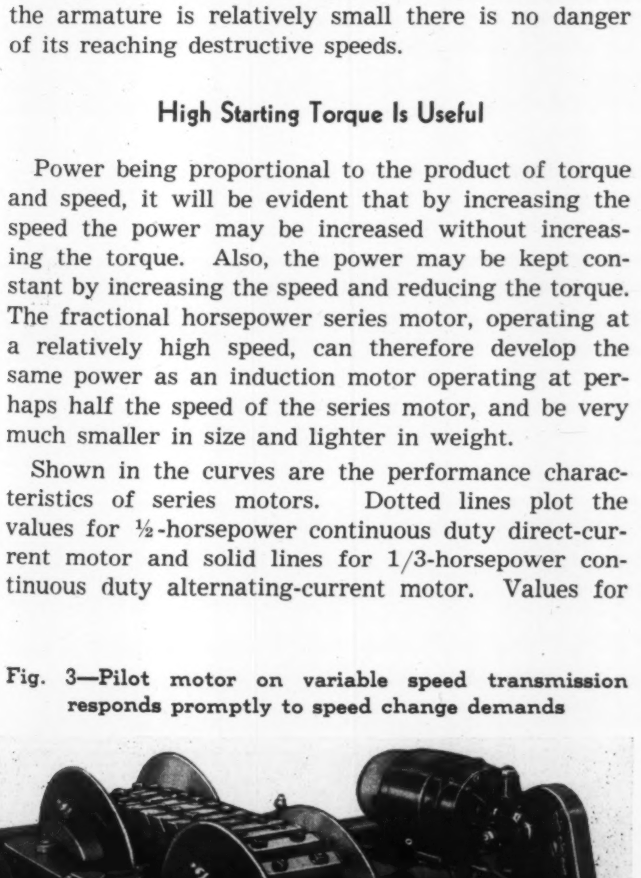
that this motor will operate at unusually high speed, full load ratings being in the range of 4000-9000 revolutions per minute. Under no load the speed is limited only by such intrinsic loads as brush and bearing friction and windage, and since the mass of the armature is relatively small there is no danger of its reaching destructive speeds.

High Starting Torque Is Useful

Power being proportional to the product of torque and speed, it will be evident that by increasing the speed the power may be increased without increasing the torque. Also, the power may be kept constant by increasing the speed and reducing the torque. The fractional horsepower series motor, operating at a relatively high speed, can therefore develop the same power as an induction motor operating at perhaps half the speed of the series motor, and be very much smaller in size and lighter in weight.

Shown in the curves are the performance characteristics of series motors. Dotted lines plot the values for ½-horsepower continuous duty direct-current motor and solid lines for 1/3-horsepower continuous duty alternating-current motor. Values for input, torque, horsepower and efficiency are plotted against speed.

Fig. 3—Pilot motor on variable speed transmission responds promptly to speed change demands



Because the resistance of the armature of a series motor is low, the current at starting, before a counter e.m.f. (voltage generated by the motor in opposition to the current produced by the impressed voltage) is built up, is high. The field flux is nearly proportional to the armature current until the magnetic circuit reaches saturation. Torque is proportional to the product of armature current and field flux and hence is high at starting. The starting torque of a fractional horsepower series motor is between three to four times its full load torque and between two to four times that of the shunt, induction and synchronous motors. The series motor, therefore, is well adapted to starting heavy loads. Because of its high starting torque this motor accelerates very rapidly, which property is useful on many applications.

Since the speed of the series motor varies directly as the applied voltage, speed variation is simply a matter of varying the impressed voltage. This is easily done by means of the series rheostat or, on alternating current only, the more efficient variable auto-transformer. Speed control from zero to maximum is possible. Speed may also be varied, over a limited range, by a rheostat shunted across the armature or by a potentiometer connection utilizing both series and shunt rheostats. The latter methods provide more stable speeds within their ranges than does the series rheostat.

The series motor, then, possesses these five advantages:

(1) It will operate on both alternating current and direct current (in the voltage range of 32-115 volts and frequency range of 0-60 cycles).

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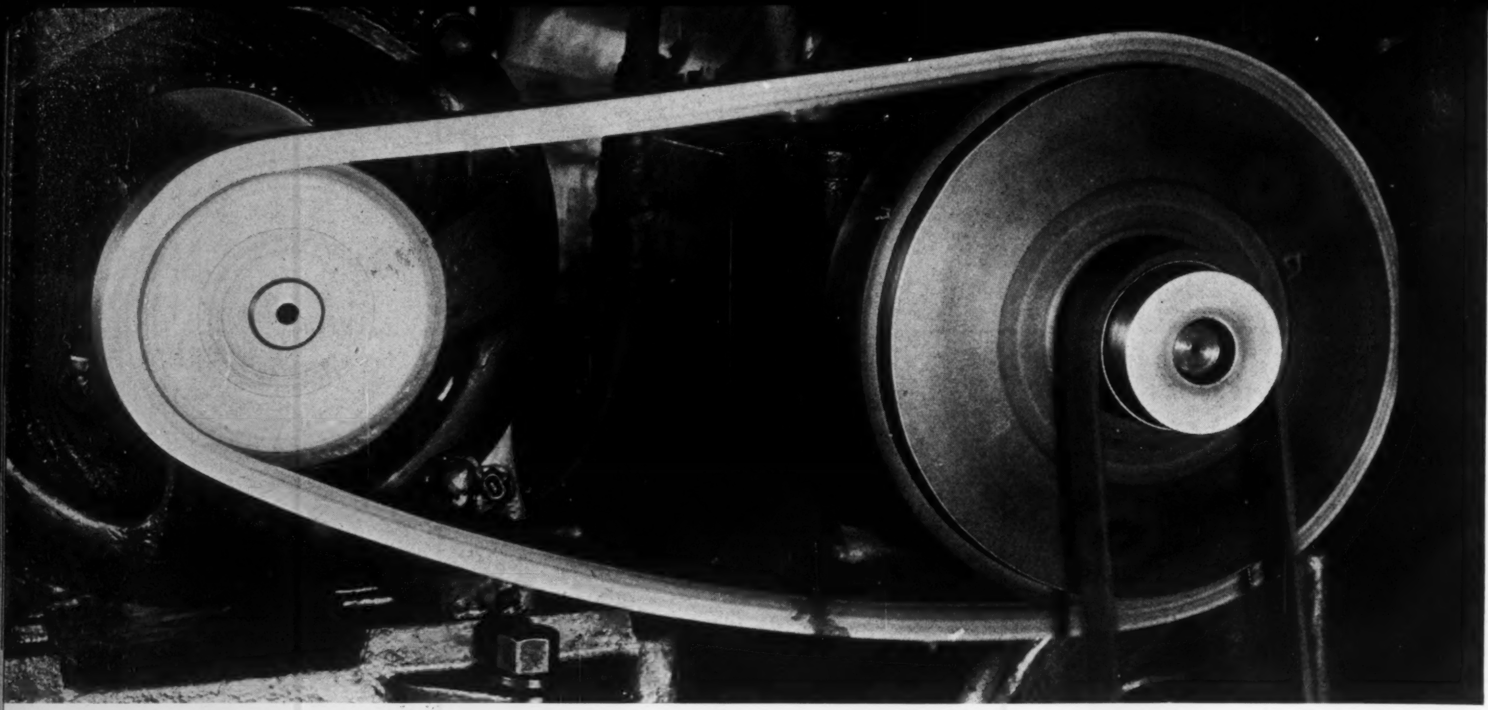


Fig. 1—Silent chain proves effective means of power transmission from motor to machine

Chain Drive Practice Seen Changing

CONSIDERABLE significance is attached to the current trend toward higher speed chain drives. For many years the recommended speed at which to run a chain, whether roller or silent, has varied little up or down from 1500 feet per minute. Selection of a chain suitable for transmitting the required horsepower at this speed, together with sprockets giving the correct speed ratio, could readily be made. Often such drives were, and still are, available "from stock."

To meet the majority of conditions for which it is advantageous to utilize chain drives, these conventional drives—or slight variations from them—are eminently suitable. It is generally recognized, however, that to meet more stringent conditions, particularly where exceptionally quiet and smooth-running drives are desired, it is advisable to go beyond the range of the stock drive and to consider the higher speed type of drive utilizing sprockets having considerably more teeth and shorter pitch chain.

Reduces Angle of Articulation

Two outstanding advantages immediately arise from increasing the number of teeth in the sprockets and employing lighter, shorter pitch chain. As indicated by *Fig.* 2, the angle of articulation through which the joints of the chain pass as the chain enters or leaves the sprocket, varies with the number of teeth. Though the diagram shows the condition on sprockets having only 12, 24 and 36 teeth, it can be seen that the larger the number of teeth the more the chain approaches a straight line in moving on to or off the sprocket—and consequently less turning occurs in each chain joint or bearing.

Further—although this point is less important in actual practice—the smaller the number of teeth in a chain sprocket the greater the tendency toward undesirable variation in chain velocity as the chain enters or leaves the sprocket. In *Fig.* 3 is shown the relationship between maximum and minimum velocities due to the difference that exists between the pitch radius and apothem of the pitch polygon. The maximum speed occurs at the instant the center of a chain pin is at the point of tangency for the working span of chain and the pitch circle. Minimum speed occurs at the instant the center of a sprocket tooth is at the effective point of tangency, as shown in the drawings in *Fig.* 2. Actually, the chain does not slow down or speed up appreciably except on particularly slow rotative speeds, due to its momentum; but as can be seen, the larger the number of teeth in the sprocket the less will be the tendency for any such change in velocity to occur.

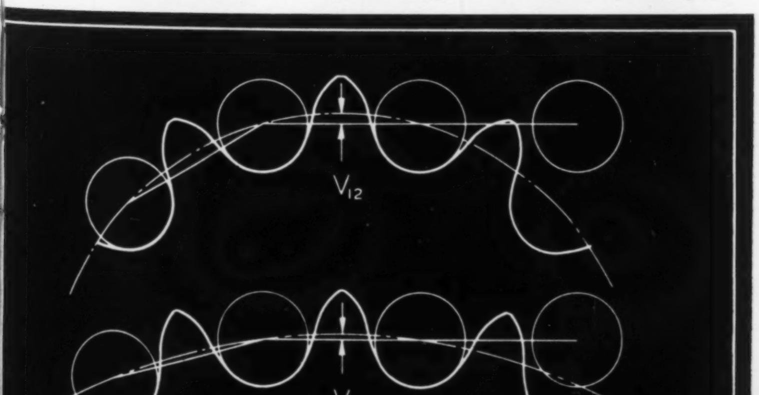
Supplementing the foregoing, another advantage arises from the use of larger numbers of teeth in the sprocket. Theoretically the action of roller chain upon entering a sprocket is for the roller to roll down the tooth form to the bottom of the tooth. Actually, however, the roller is apt to strike the bottom—or near the bottom—of the tooth with some force, and this is increasingly accentuated as the numbers of teeth in a sprocket are reduced. The same thing applies in the case of silent chain, but because of the action of engagement of silent chain upon sprocket teeth there is still less possibility for noise to be created.

Lighter Chain May Be Used

All of the points thus far discussed have dealt with obtaining smooth-running, quiet drives, with minimum wear in the chain joints. There is, however, still another important advantage to be gained from the use of larger numbers of teeth in the sprockets. Because the horsepower a chain is capable of transmitting is a function of the linear speed of the chain, it follows that—other conditions permitting—a lighter chain with lower tensile strength may be utilized for transmitting a required horsepower if the number of teeth in the sprockets is increased and the chain run at higher speed. This point is brought out in the chart in *Fig.* 5 which shows the increased horsepower obtainable per inch width of silent chain running from low to higher speeds. In this particular chart the curves are based on the use of a sprocket having 45 teeth running at different speeds; but similar results are, of course, obtainable if the rotative speed remains the same and the diameter of the sprocket is increased to give higher chain speed.

Recent development work of at least one of the large chain manufacturers has evolved around so-called high speed drives with the smaller sprocket having in the range of 33 to 65 teeth. Therefore, the chart just discussed, based on a 45-tooth sprocket for each chain, can be taken as representative of this range of teeth. The curves of this particular chart and the corresponding horsepowers do not take into account one of that factors that has generally been considered important in high speed drives—centrifugal pull. Research by this company has shown that centrifugal pull reacts against the rear or trailing edges of the sprocket teeth—particularly on low ratio drives—and therefore does not add to the total load on the chain to the extent previously believed in drives of the higher speed type.

Fig. 2—Below—Much advantage is gained by using sprockets having larger numbers of teeth and thus reducing the angle through which chain joints pass



The change of thought in connection with the effect of centrifugal pull can better be appreciated when it is remembered that the higher speed drives necessarily are restricted to relatively low ratios. With a smaller sprocket in the region of 33 to 65 teeth, and with a desirable limit to the number of teeth utilized in the large sprocket, it follows that the highest ratio permissible with this type of drive is 4:1; preferably it should not exceed 3:1. Assuming for a moment an even speed of 1:1, with full 180 degrees chain wrap around each sprocket—or with relatively low ratios—centrifugal force might well be proved a much less important factor than would be the case with ratios of 6 or 7:1 where the wrap around the smaller sprocket is greatly reduced.

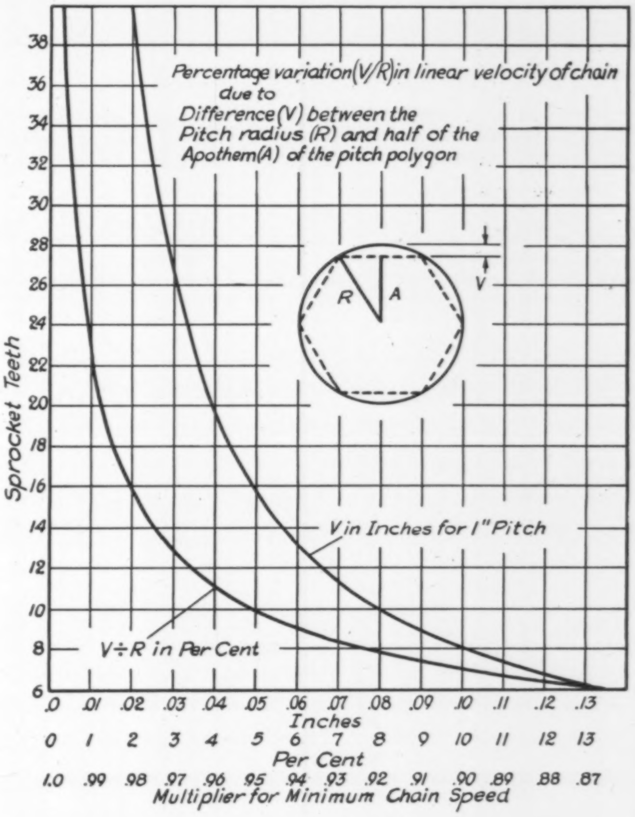


Fig. 3—Though negligible on normal drives, chain volocity tends to vary due to polygonal action. This is naturally more severe on sprockets having few teeth

Press Drive Is Typical

Typical of the application of high speed chain drives involving many of the foregoing considerations is the illustration shown in *Fig.* 4. Not only is the drive special, but the press on which it is installed is claimed to be the world's fastest, turning out as many as 60,000 complete newspapers per hour. Four silent chain drives operate the machine in conjunction with four 100-horsepower motors and four herringbone gear reduction units of the two-speed type.

Through the reduction units the press shaft speeds may be set at 1500 or 2000 revolutions per minute;

the motors run at 1750. Silent chain drive forms the direct connection between output shaft of gearbox and press shaft, as shown in *Fig.* 4, the illustration for which was taken from the press room floor several feet below the drive.

Each drive on this machine utilizes ⅝-inch pitch chain, 6 inches wide, running over two 44-tooth case-hardened sprockets. With the press shaft rotating at 2000 revolutions per minute the chain speed is 4583 feet per minute. This brings the drives well within the range of the high velocity chain drive class under discussion.

Engineering Collaboration Essential

Many other drives of this special character could be cited to emphasize the advantages of high chain speed combined with large numbers of sprocket teeth and relatively light, short pitch chain. It should, however, be remembered that these drives are always carefully engineered in collaboration with the chain manufacturers and that certain measures are essential for satisfactory operation and long life of the drives.

Adequate lubrication, for instance, is a prerequisite. Ordinarily this is taken care of by enclosing the drive in a chain case (as in the illustration), and furnishing continuous lubrication by means of a circulating oil pump. In other instances the splash system is effective because the high chain velocity creates windage that causes sufficient disturbance of the oil at the bottom of the case to raise the oil level and keep the chain well lubricated. The oil in these instances tends to form a mist within the case.

In conclusion, it should not be inferred that all, or even the majority, of chain drives of the future will involve high chain velocities. The conventional drive with chain speeds in the 1500-2000 feet per minute range fills a definite need. In view, however, of the advantages of quietness, smooth running and long life gained by combining greater numbers of teeth in the sprockets with shorter pitch chains, the trend unquestionably will be in this direction.

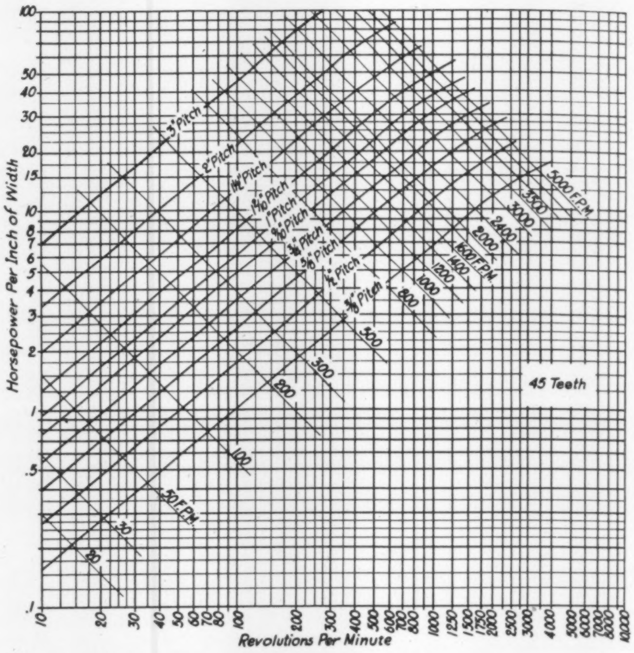


Fig. 5—Chart indicates the increase in horsepower various chains will transmit by running them at higher speeds

For their considerate assistance in the preparation of this article MACHINE DESIGN wishes to thank: Baldwin-Duckworth Div., Chain Belt Co.; Boston Gear Works Inc.; Chain Belt Co.; Diamond Chain & Mfg. Co. (*Figs.* 2 and 3); Link-Belt Co. (*Fig.* 4); Morse Chain Co. (*Fig.* 5); Ramsey Chain Co. Inc. (*Fig.* 1); and the Whitney Chain & Mfg. Co.

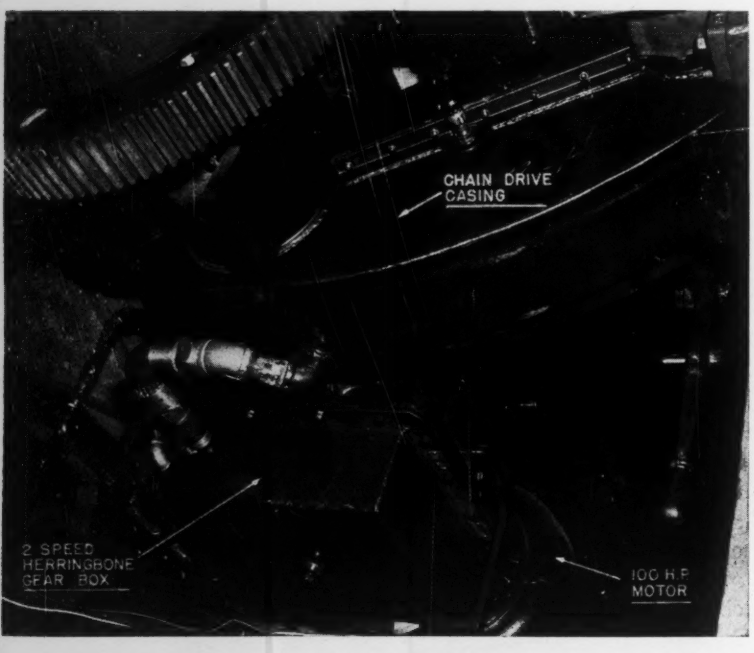
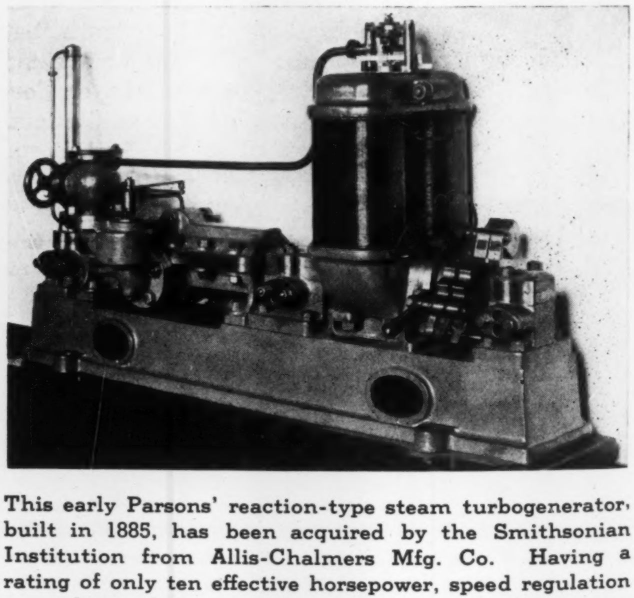


Fig. 4—High speed drive to shaft of printing press. Chain, running at 4583 feet per minute, is totally enclosed in case and lubricated from oil pump



This early Parsons' reaction-type steam turbogenerator, built in 1885, has been acquired by the Smithsonian Institution from Allis-Chalmers Mfg. Co. Having a rating of only ten effective horsepower, speed regulation was obtained by a spring-loaded leather diaphragm operable from a fan-induced vacuum. Position of a magnetically attracted soft iron bar on the field magnets supplied further regulation according to the field intensity of the generator. Turbine blade rings are solid gunmetal

Pick the Right Control

By L. E. Markle

Control Engineer
Westinghouse Electric & Mfg. Co.

FOR satisfactory operation of any machine the driving motor and the means for controlling it must be carefully selected. Many applications require speed adjustments and demand such accuracy of control that direct current equipment is used. Other motions that do not require adjustable speed features are equipped with either constant-speed, direct-current motors or squirrel cage, alternating-current motors.

Since a squirrel cage motor requires less space than an equivalent constant-speed, direct-current one, and is also less expensive, the more complicated machines that have many different motions may use squirrel cage alternating-current motors for the constant-speed motions and direct-current motors only where speed adjustments are necessary.

On motions that require quick and accurate stopping in order to avoid damage to the machine, direct-current motors are used because dynamic braking for quick stopping is easily applied. Regardless of the cost and space item some installations use direct-current motors throughout because certain motors must be direct-current and similarity of apparatus is desired.

Control equipment for motors is, of course, important because it insures protection of electrical equipment and is the medium that con-

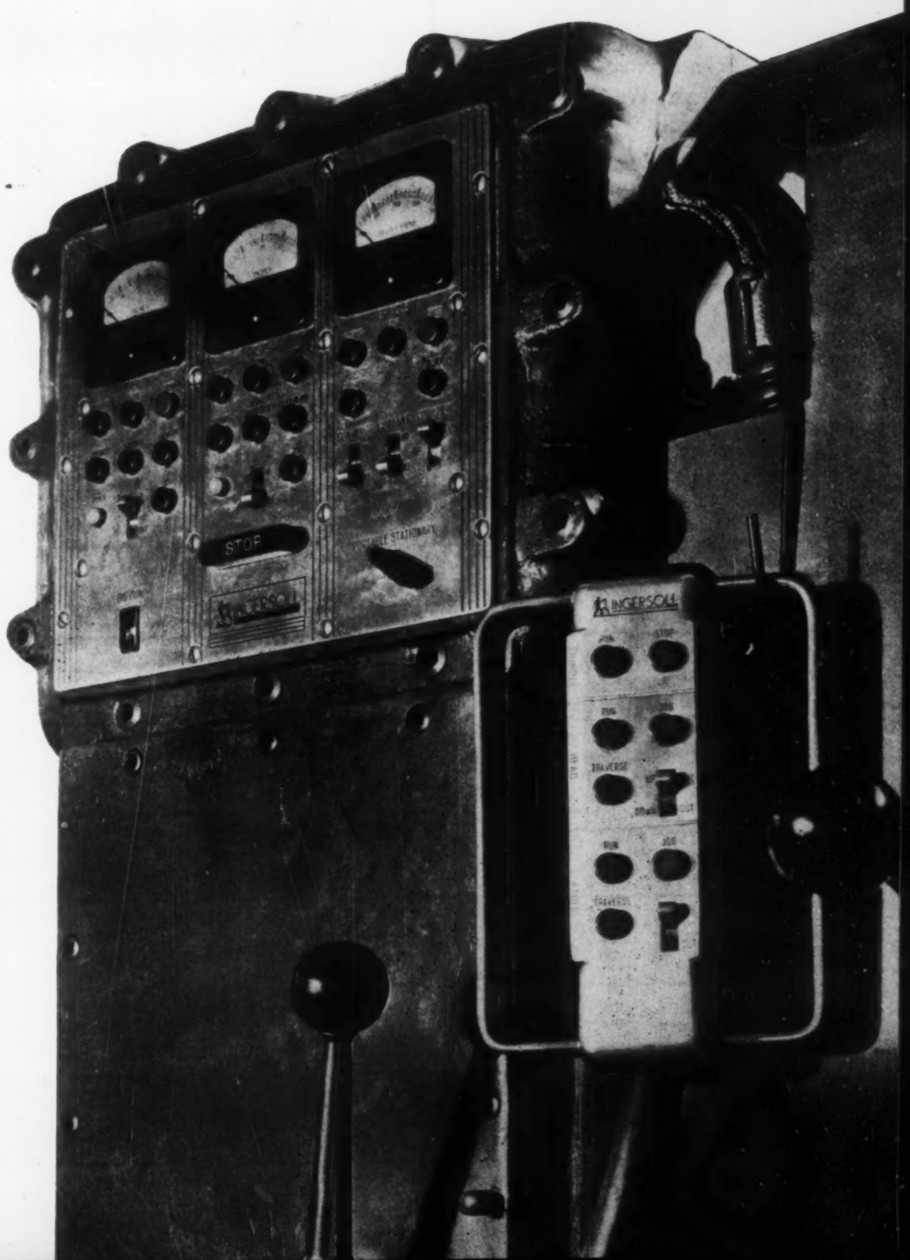
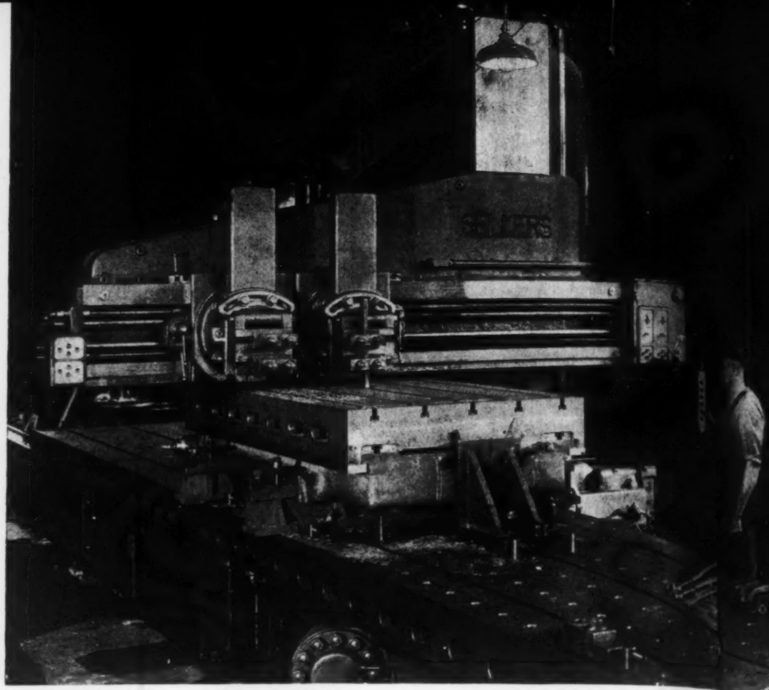


Fig. 1—Control station for an Ingersoll milling machine. Motor-operated field rheostats provide remote control of spindle and feed speeds



trols the operating features. It furnishes means for the operator to select the desired operation of the motor at all times; provides automatic features as required; gives the operator devices that are electrically safe and easy to operate; protects the motor in case of dangerous overload conditions.

In the accompanying tabulation are indicated the type of control and features that are generally provided for each of the common kinds of motors. This tabulation also shows typical applications upon which each variety of motor and control is frequently applied.

Built-in Control Aids Design

All control may be divided into two groups, manual and magnetic. Manual control, as the name implies, is operated directly by the attendant and the devices themselves carry the circuits that are to control the motor operations. Such devices always have operating handles and are thoroughly insulated to protect the operator. Magnetic controllers carry motor currents through magnetically operated switches or contactors that can be located either on the machine or in a remote place. The operator's control station may then be a small unit, such as a pushbutton, located in a convenient place near the operator.

Some starters have a pushbutton station mounted on the cover of the enclosure, the entire assembly flush type for mounting conveniently within the frame of a machine.

Manual controllers should always be located near the operator and must carry the motor circuits. Since a magnetic control panel is connected to the motor and pushbutton station only by cables or wires, it may be located on the machine or in any remote place. Controllers however should always be accessible for ready inspection and maintenance. No electrical equipment should be located so near to the floor that it is subject to dirt and moisture from splashing or sweeping. It is good practice also to locate equipment above the level where chips, lubricants or cooling fluids might interfere with operation.

Machine designers usually lay out machines complete with motors and control in place as part of the

Controllers To Use for Various Motors

MOTOR			MANUAL CONTROL			MAGNETIC CONTROL			CIRCUIT PROTECTION
			REVERSING AND NONREVERSING			REVERSING AND NONREVERSING			
TYPE	FEATURES	TYPICAL APPLICATION	FULL VOLTAGE STARTING	REDUCED VOLTAGE STARTING	SPEED ADJUSTMENT	FULL VOLTAGE STARTING	REDUCED VOLTAGE STARTING	SPEED ADJUSTMENT	
GENERAL PURPOSE SQUIRREL CAGE 1-200 H.P.	normal starting torque normal starting current	pumps textile cement sugar	manual starters 7½ h.p. max.	auto transformer starter	pole changing means	line starter	primary resistance or auto transformer starter	pole changing means	circuit breaker or safety switch
LINE START CLASS I SQUIRREL CAGE 1-200 H.P.	normal starting torque low starting current	grinders cement woodworking	"	"	"	"	"	"	"
LINE START CLASS II SQUIRREL CAGE 1-200 H.P.	high starting torque low starting current	conveyors compressors	"	not commonly used	"	"	not commonly used	"	"
HIGH SLIP SQUIRREL CAGE 1-200 H.P.	normal starting torque normal starting current	punch press shears	"	"	"	"	"	"	"
WOUND ROTOR 1-200 H.P.	high starting torque low starting current	mine hoists fans oil well printing	not used	secondary resistance	secondary resistance	not used	secondary resistance	secondary resistance	"
SINGLE PHASE SQUIRREL CAGE* 1—7½ H.P.	split phase, capacitor or repulsion starting	fans grinders domestic shop	manual starters	primary resistance	not commonly used	line starter	not commonly used	not commonly used	"
CONSTANT SPEED D.C. 1-200 H.P.	ample starting torque some speed adjustment	fans pumps compressors line shafting	manual starters 2 h.p. max.	armature resistance	armature and field resistance	line starter 2 h.p. max.	armature resistance	field rheostat	"
ADJUSTABLE SPEED D.C. 1-200 H.P.	wide range speed adjustment	machine tools paper rubber mining	not used	"	"	not used	"	"	"

*Single phase motors are not generally used for reversing service

Fig. 2—This Sellers planer concentrates all necessary controls in the movable pushbutton pendant. Control scheme also automatically stops the platen if voltage fails

equipment. This practice permits a final installation of excellent appearanace and indicates complete planning of the entire installation by the designer. Naturally there are no forgotten parts that must be added at the last minute, thereby impairing the appearance of the initial design.

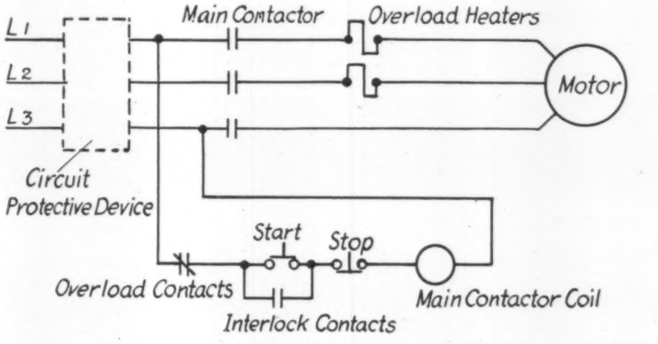
For these designs, control apparatus is frequently located within pedestals or frame structures, *Fig.* 1. Such apparatus should be easily mounted, compact, readily wired, and each item complete as a unit rather than an assembly of miscellaneous parts. Magnetic contactors and relays of unit construction for built-in type control assemblies can be mounted within the frame of a machine without additional insulation. All connections are made on the front.

Built-up Controls from Unit Parts

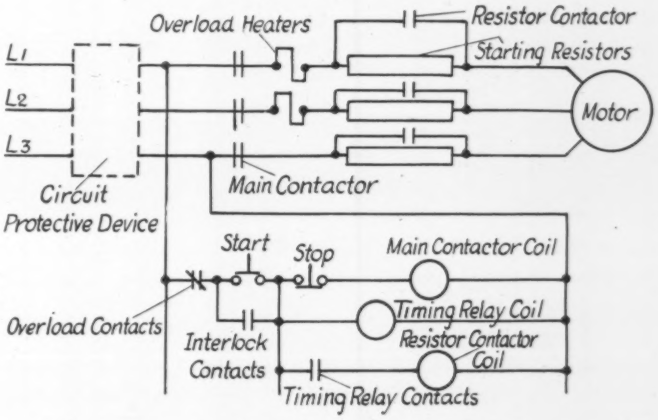
Pushbutton stations or individual pushbutton units are easily mounted with all wiring connections made within the machine and only the buttons visible on the outside, *Fig.* 2. Any number of buttons can be used and suitable nameplates can be added to indicate the proper functions of the various buttons in the unit.

Several schematic connection diagrams are shown in *Fig.* 3, in which apparatus has been identified. These diagrams indicate how complete starters can be built from self-contained unit apparatus parts. Typical cases are given including nonreversing full voltage starter, nonreversing—resistance type starter and reversing full voltage starter for squirrel cage

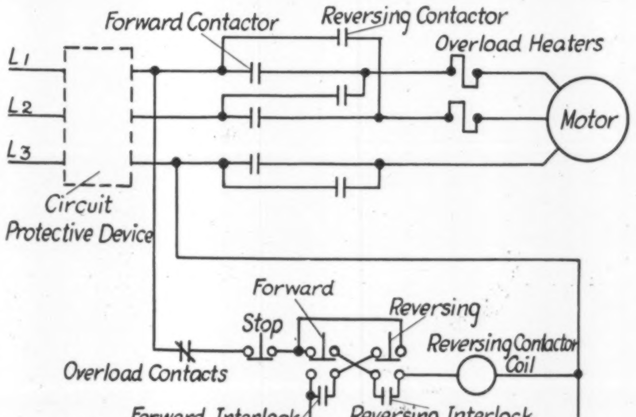
(*Continued on Page* 68-S)


L1
L2
L3
Main Contactor
Overload Heaters
Motor
Circuit Protective Device
Start
Stop
Overload Contacts
Interlock Contacts
Main Contactor Coil

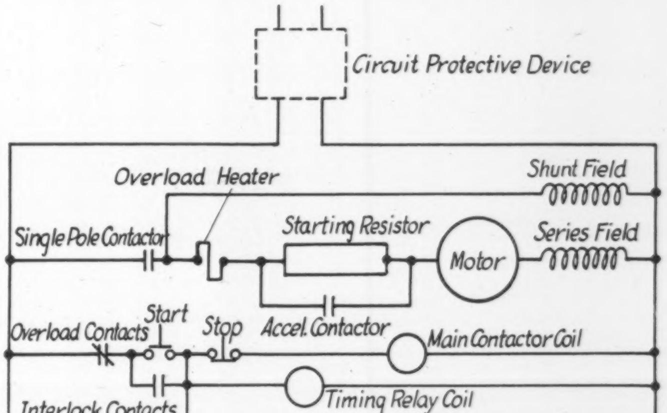
nonreversing, full voltage starter for squirrel cage motor


Overload Heaters
Resistor Contactor
Starting Resistors
L1
L2
L3
Motor
Main Contactor
Circuit Protective Device
Start
Stop
Main Contactor Coil
Overload Contacts
Timing Relay Coil
Interlock Contacts
Resistor Contactor Coil
Timing Relay Contacts

nonreversing, resistance starter for squirrel cage motor


Forward Contactor
Reversing Contactor
Overload Heaters
L1
L2
L3
Motor
Circuit Protective Device
Forward
Reversing
Stop
Reversing Contactor Coil
Overload Contacts
Forward Interlock
Reversing Interlock
Forward Contactor Coil

reversing, full voltage starter for squirrel cage motor


Circuit Protective Device
Shunt Field
Overload Heater
Starting Resistor
Series Field
Single Pole Contactor
Motor
Start
Overload Contacts
Stop
Accel. Contactor
Main Contactor Coil
Timing Relay Coil
Interlock Contacts
Accel. Contactor Coil
Timing Relay Contacts

nonreversing, resistance starter for d. c. motor

Fig. 3—Simplified schematic diagrams of typical control applications. Standard units may be used in this way to obtain various types of controllers for built-in applications

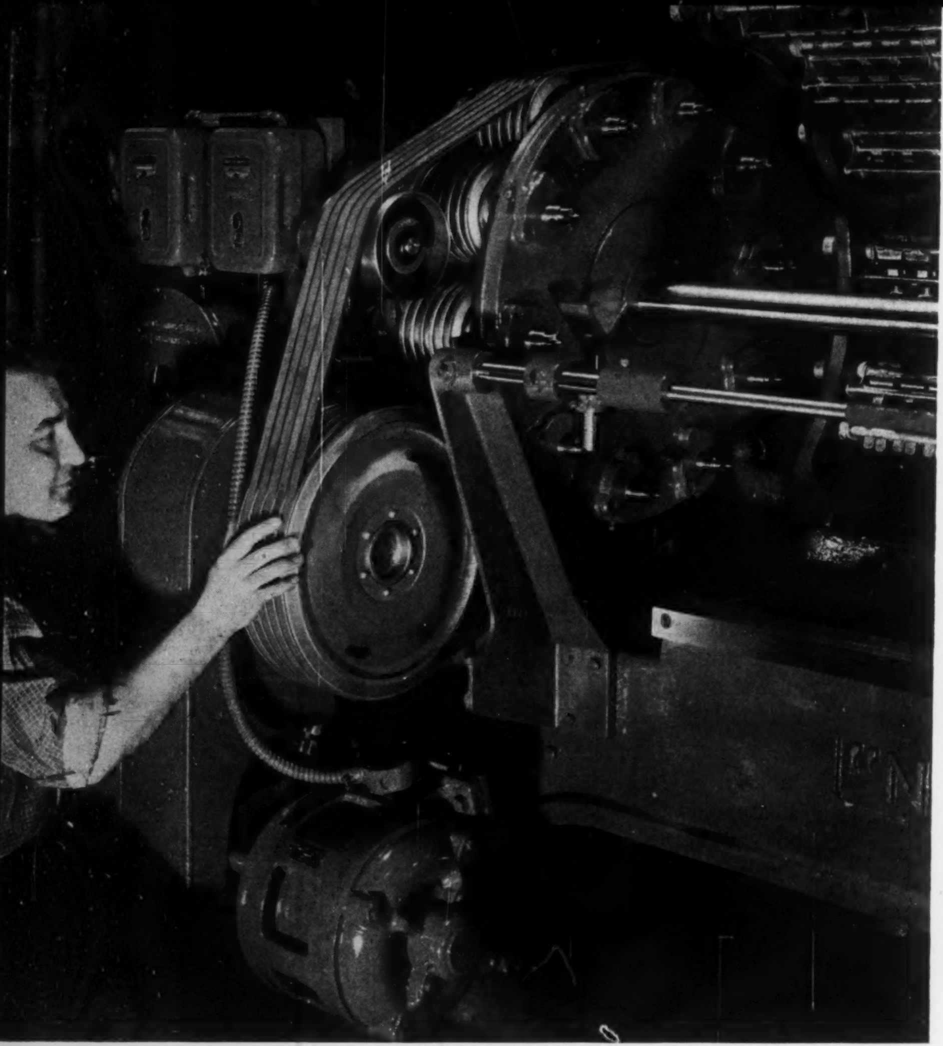
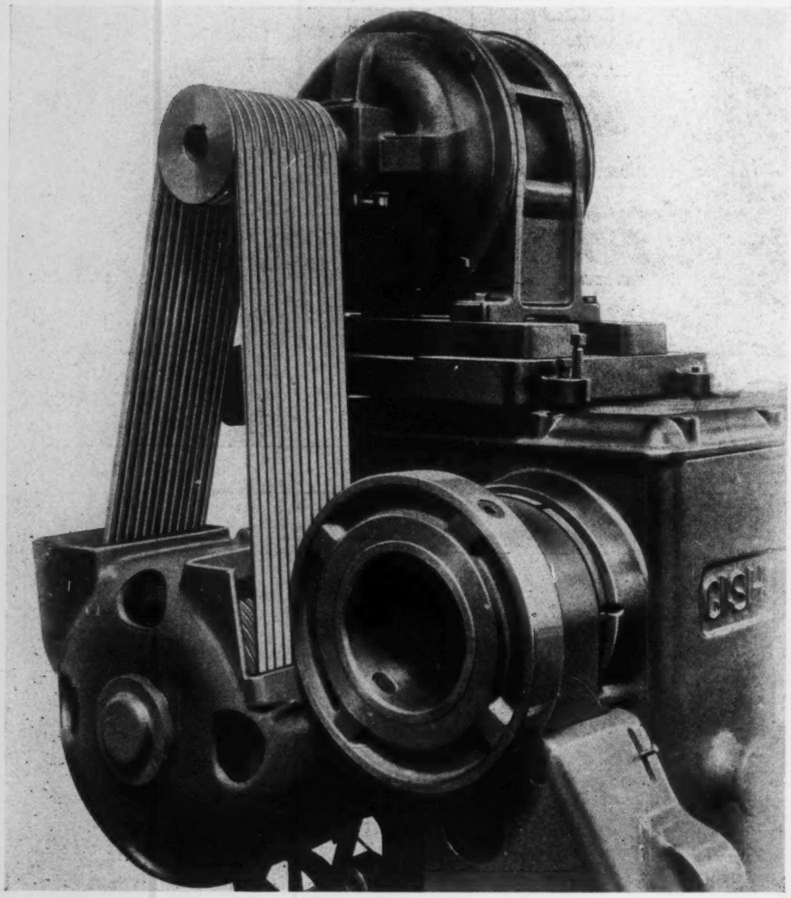


Fig. 1—Arc of contact on each of the ten driven pulleys on this sanding machine is much smaller than usual. Fig. 2—Below—V-belts function equally well regardless of whether the driver is above or below the driven pulley, as comparison of this lathe with Fig. 3 will indicate



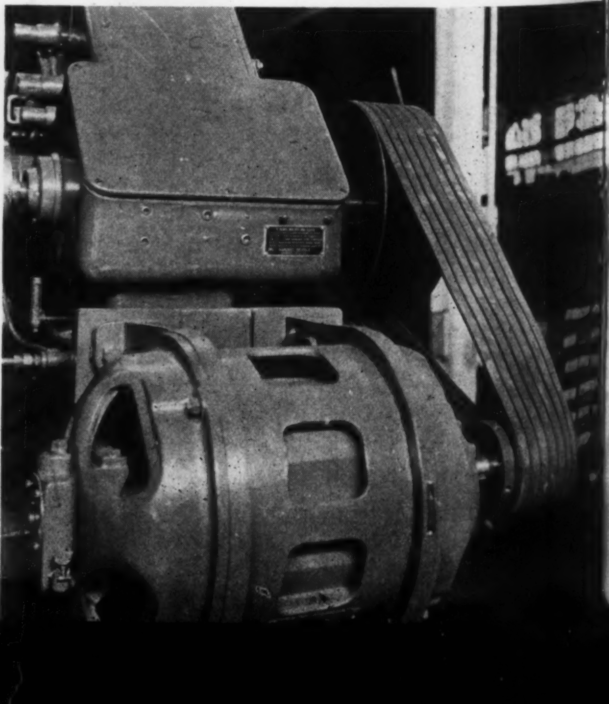
Built-in V-Belt

By

George Z. Griswold

AS ONE phase of the comparatively recent trend toward short-center belt drives, V-belts have gained wide built-in application in machines ranging from fractional horsepower units to those with capacities of several hundred horsepower. Most of the peculiar advantages of V-belts arise from the essential principle back of them, that of an endless belt of trapezoidal-shaped cross-section running on pulleys or sheaves with a corresponding V-shape. These advantages include almost negligible slippage, with consequent greater gripping and pulling power; space saving, because approximately only one-third of the driving pulley need be in contact and the motor may then be located closer to the driveshaft; quietness; cleanliness; absence of unusual strain on bearings; strong, smooth operation, with shocks cushioned.

Fig. 3—Below—A conventional V-belt drive on a gang drill. Large but few belts are used



elt Drives Save Space

For maximum turning effect on all belt drives, friction between the belt and the surface of the pulleys must be developed in one way or another. The V-belt utilizes "wedge-action" to build up the pressure between the surfaces of the belt and pulleys without increasing tension in the belt. Pressures are exerted by the two angular sides of the groove and the downward force caused by pull of the belt. Angles of the sides of the pulleys usually range from around 30 degrees to 38 degrees, a smaller angle being used to obtain greater wedging action in small pulleys where the angle of wrap of the belt tends to diminish.

Although V-belts operate on short centers, the center distance in ordinary applications should not be so short in comparison with the pulley diameters that the arc of contact becomes less than 120 degrees. But even this latter figure is smaller than with other types of belts. In this connection the familiar rule-of-thumb is often cited, namely, that if the distance between the shafts equals or is greater than the diameter of the large sheave, there is sufficient contact.

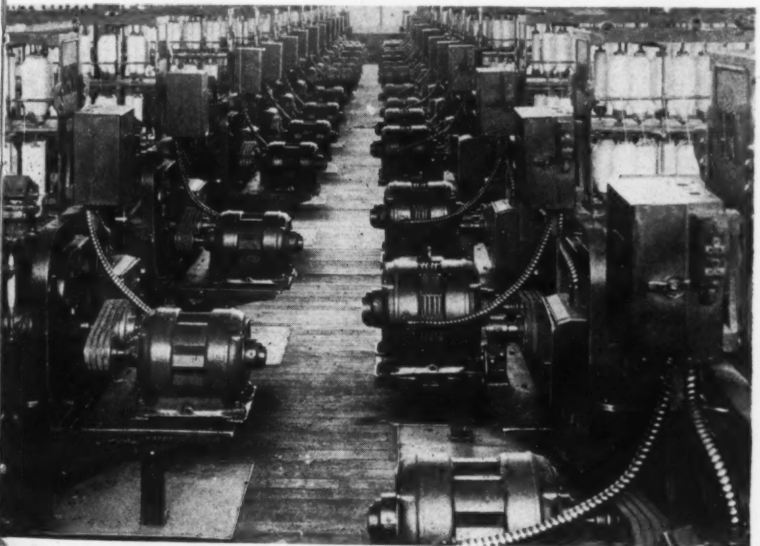


Fig. 4—V-belts provided clean, quiet drives in this textile mill, and also permitted more floor and ceiling space

The V-belt application in *Fig.* 1 is particularly notable because it illustrates an instance where the arc of contact is much smaller than usual. The load on each spindle of this sanding machine is not required to be great and it was found that because of the tight grip of the V-belt on the individual pulleys, the small contact arc was sufficient. It will be apparent that at the same time the bearing pressures are lessened. Moreover, because not all the sheaves are in contact with the belt at all times, an automatic clutching effect is supplied when the belt leaves or resumes contact with the pulley. Note use of the idler to insure uniform contact on all sheaves. It goes without saying, however, that in special cases like this, the manufacturer's help should be secured.

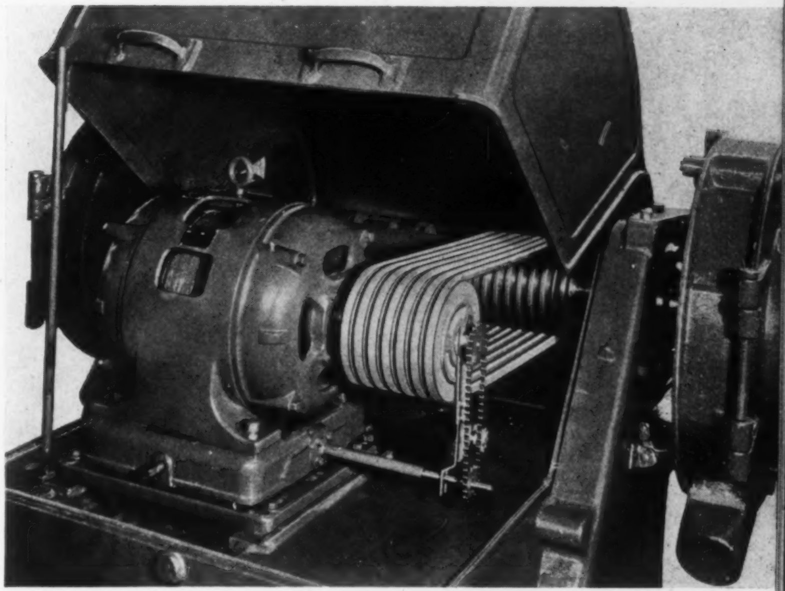


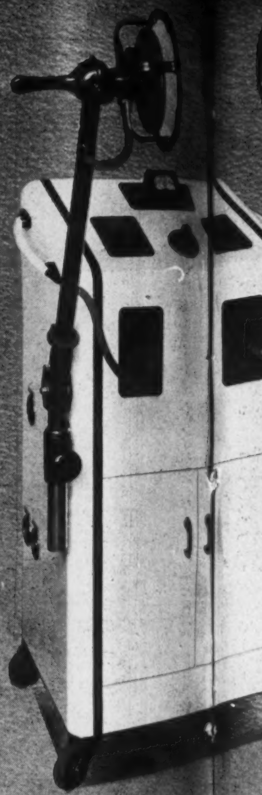
Fig. 5—Sheaves with variable pitch diameters, like these on a grinder, may be used when it is desirable to adjust speed ratio without intermediate means

V-belts function equally well regardless of whether the drive is vertical, horizontal, or somewhere in between; the driver may be above or below the driven pulley. *Figs.* 2 and 3, a lathe and a gang drill, respectively, illustrate contrasting examples. *Fig.* 3 is somewhat more conventional because larger but fewer belts are used. More belts mean wider pulleys and increased bearing pressure. In this connection, the standard practice is to keep the overall width of the V-belts equal to or less than the diameter of the small pulley, although special conditions may make this rule unnecessary. Belt life, of course, will be reduced by using pulleys that are too small and it is safer to use pulleys having a diameter slightly greater than the recommended minimum. The standards for minimum pulley diameters for use with belts in each of the five sizes should be consulted.

The question of the best V-belt speed remains somewhat moot, although the most practical limits are from 1000 to 5000 feet per minute. Maximum

(*Continued on Page 72-S*)

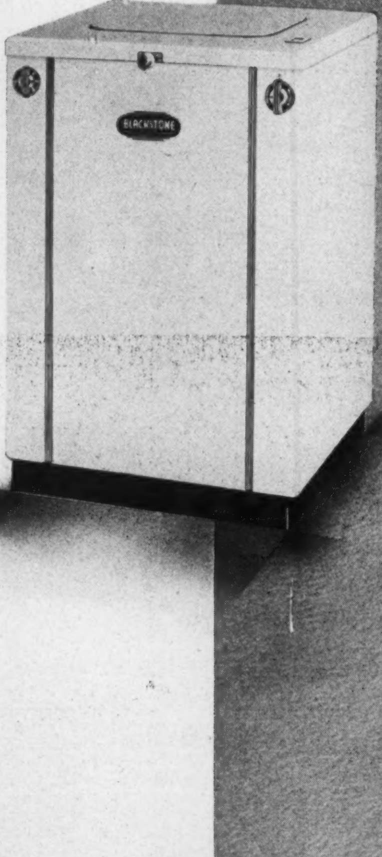
Selection of the correct wave length is automatic in the Liebel-Flarsheim short and ultra-short wave generator (right). After plugging in terminals, the circuit is immediately switched to the proper current. All controls are on top of the machine and are visible and accessible from any side of the unit. Finish is a smooth baked-in lacquer which retains its elasticity



The Reliable fur cleaning machine (above) has a one-third-horsepower motor for driving the drum, ball bearing transmission, and suspension chain drive. A smaller motor drives the exhaust blower. Interior of the machine is made up of four air-tight compartments, one housing the drum motor and transmission. Shutter control lever at right removes cleaning compound from compartment

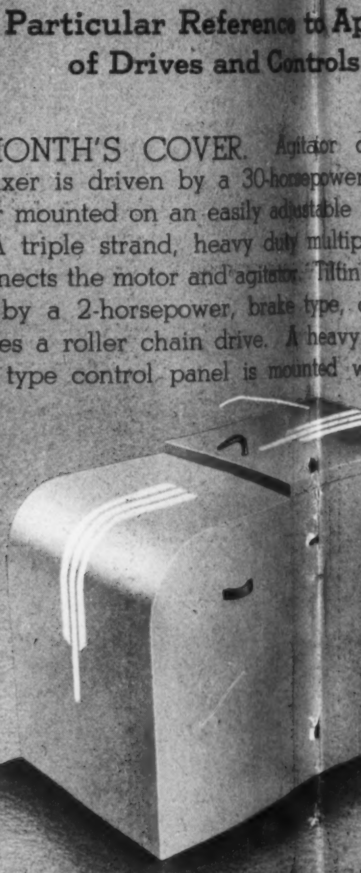
Design Feat
In New Mach

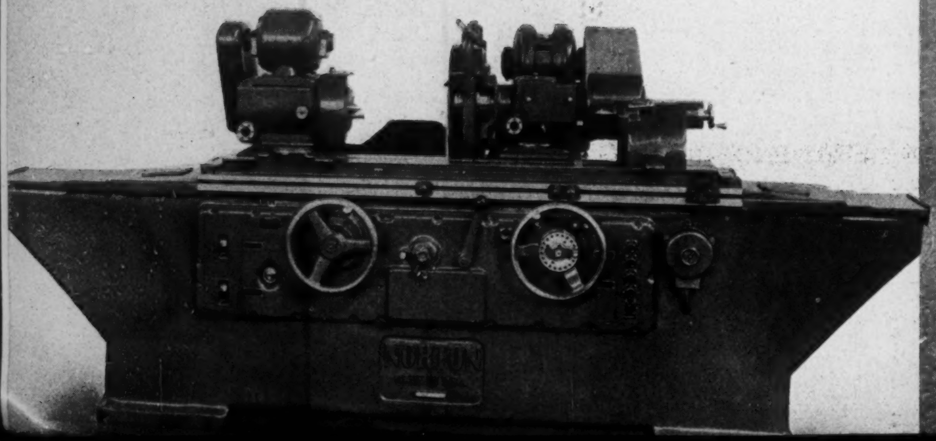
With Particular Reference to Ap
of Drives and Controls



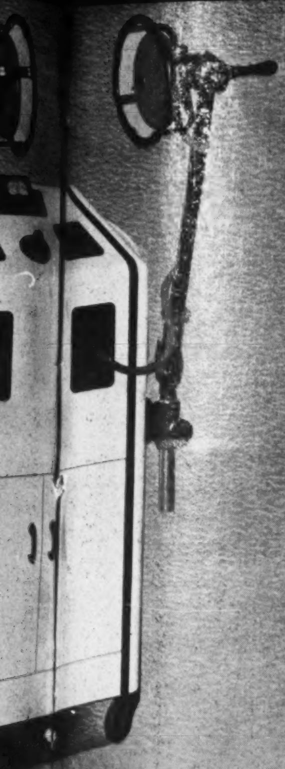
Two convenient controls at the front of the Blackstone automatic washer (right) actuate its entire operation. They regulate water temperature and length of washing period. The complete automatic washing cycle is achieved through a simplified control system that is entirely mechanical. Vibration is smothered at the source by an original design of vertical axis tub mounting and by floating the complete motor and driving mechanism assembly on live rubber cushions. Cabinet is white enamel, attractively styled

THIS MONTH'S COVER. Agitator o
dough mixer is driven by a 30-horsepower
gearmotor mounted on an easily adjustable
frame. A triple strand, heavy duty multip
drive connects the motor and agitator. Tiltin
operated by a 2-horsepower, brake type,
also utilizes a roller chain drive. A heavy
contactor type control panel is mounted w

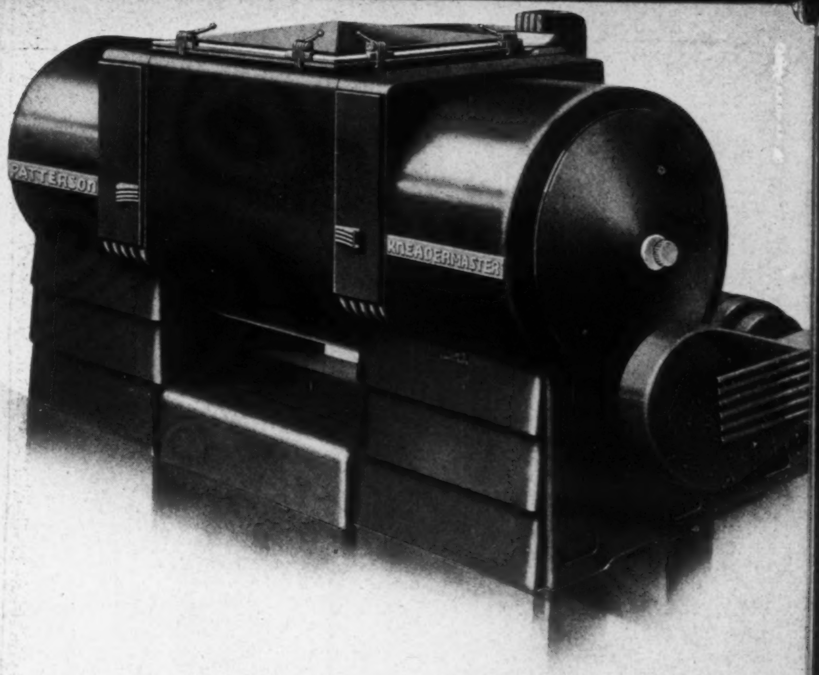




An electric table dwell control on the Norton multi-purpose grinder (left) can be adjusted to give dwell between one-fifth of a second and 120 seconds. Fast or slow traverse is obtained through a small lever back of the table drive handwheel, by a 24 to 12 reduction. Electrical control equipment is centralized at the rear. Oil and coolant pumps are driven by individual motors and are spring mounted to isolate vibration



The Patterson Kneadermaster mixer (right) is driven by a horizontal motor drive mounted integrally with the machine on the smaller sizes and by multiple V-belts on larger machines. Freedom from gear and shaft stresses is assured by wide faced, helical cut steel gears, none of which are overhung. Mixer body is mounted on oversize center trunnions to prevent wear and settlement under load, and dumping is achieved by an inbuilt motor with pushbutton control



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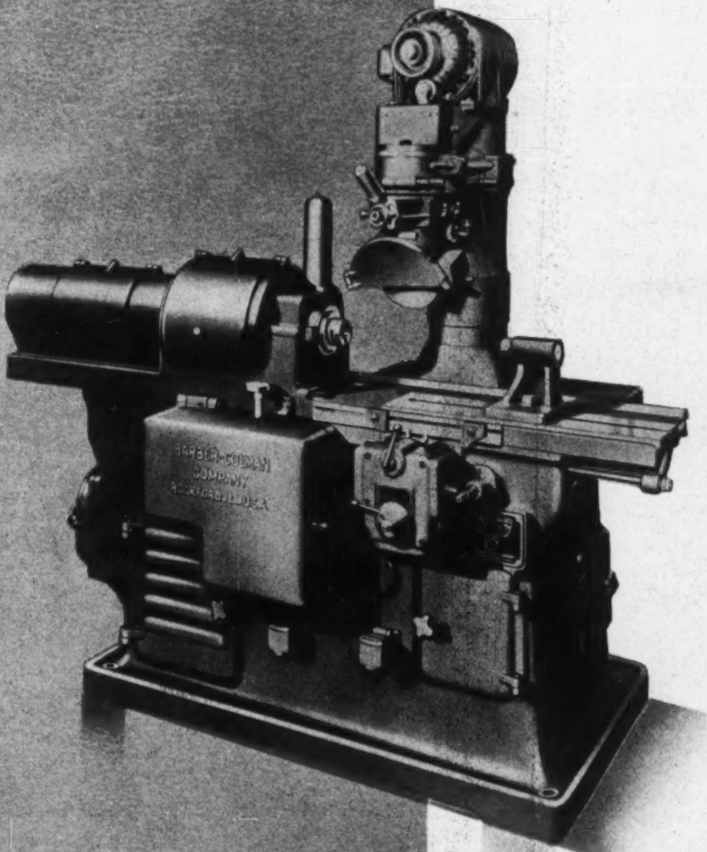
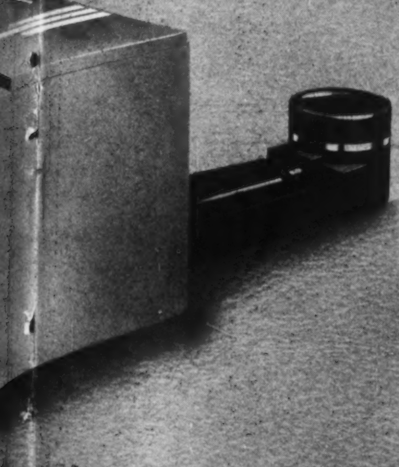
nce to Application
Controls

Agitator of the Readco
horsepower squirrel cage
adjustable base inside the
duty multiple roller chain
tor. Tilting mechanism is
ke type, gearmotor, and
A heavy duty magnetic
mounted within the base

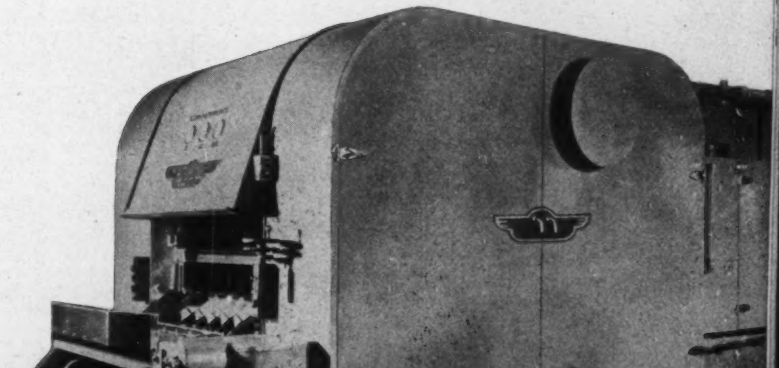


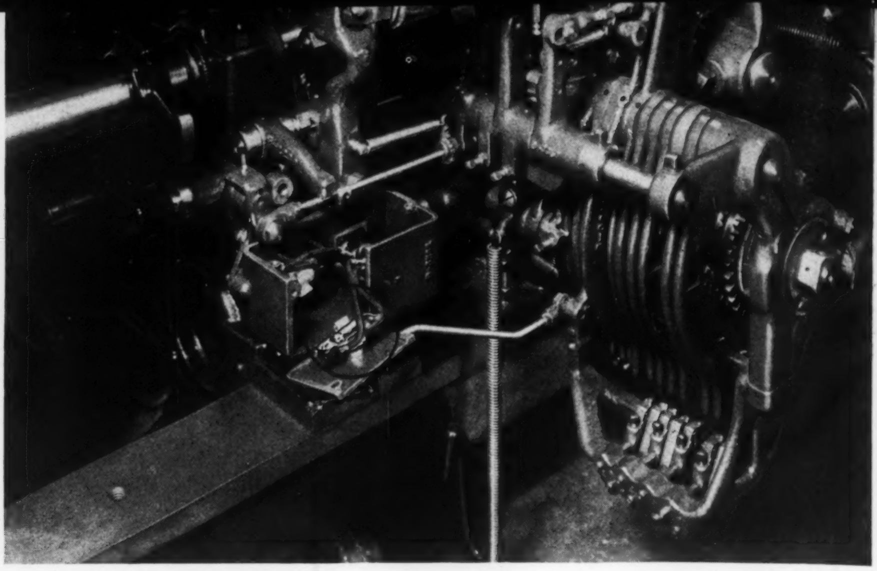
An hydraulic table drive on the Barber-Colman hob sharpener (left) affords instant control of traversing speed. By means of an adjustable dog the length of the stroke also can be controlled to suit the face of the work. An automatic mechanism indexes the work through an adjustable sine bar which actuates a rack and pinion. The grinding wheel head and its individual motor drive are supported on an upright and the entire wheelhead can be raised or lowered

A brake motor controlled by the pushbutton in left lower foreground powers the Barry-Wehmiller bottle cleaner (below). This pushbutton control is automatically linked to a diaphragm type solenoid valve which shuts off rinse water supply whenever the machine stops. The brake motor transmits power through a variable speed pulley to a worm reducer, which in turn drives a spur gear reduction unit. Intermittent motion is imparted to the bottle carriers by a slow Geneva motion driven by the spur reduction



A vanadium alloy steel screw, heat treated to resist wear, has been introduced in the Northern Steel Stokerator (above), where it replaces the old type worm. The constant speed transmission is fully equipped with ball bearings and has no pawl or ratchet. An exclusive type fan automatically maintains desired air pressure. The fuel bed is kept at its highest efficiency by an automatic air damper control. A one-sixth horsepower motor furnishes power





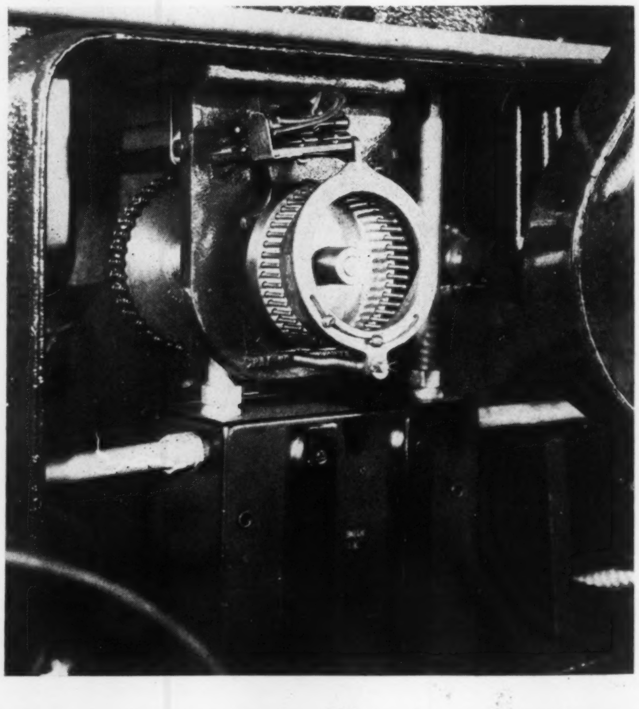
Operated by lever action from machine part, this small mercury switch is mounted near controlling action, simplifying design

By G. W. Birdsall

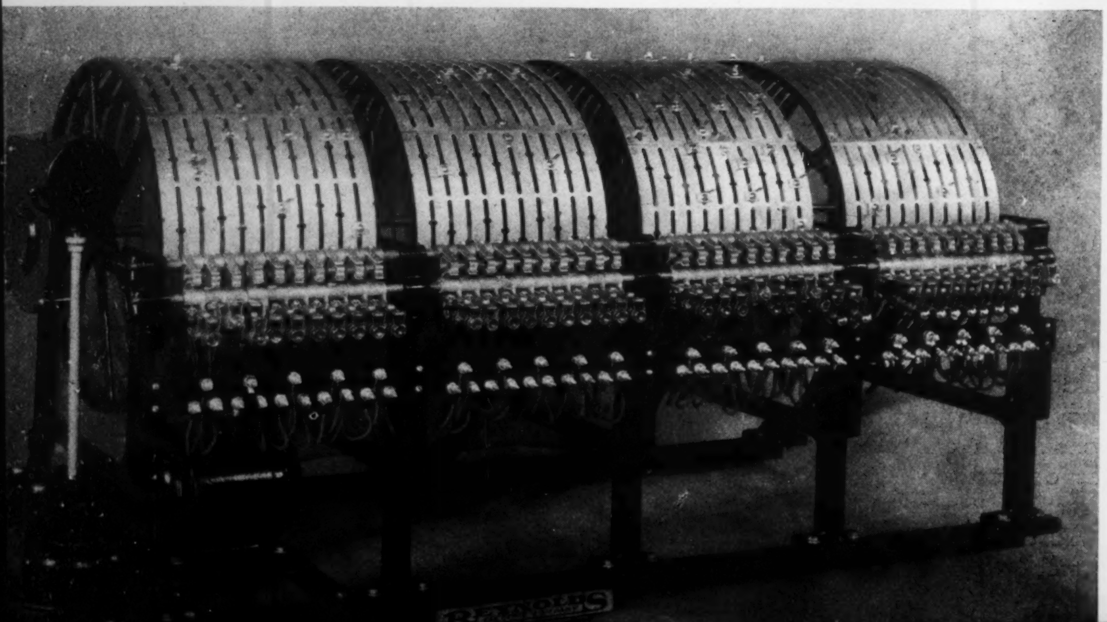
Mercury Switches Are Versatile!

SATISFACTORY operation of even the simplest machine often hinges directly upon the dependability of electric contacting elements employed in its control. Wherever control equipment involves making or breaking electric contacts, mercury switches merit careful consideration because of their many features.

Regardless of the type, make, size or design of the particular mercury switch used, a good positive low-resistance electric contact is assured for each operation since the contact is made either between mercury-to-mercury or mercury-to-special-metal contacting surfaces. Contacts are sealed completely, affording ample protection against dust, dirt, atmospheric deposits or corrosion of contact surfaces. In addition, oxidation of the contacting surfaces is prevented by withdrawing all oxygen from the interior of the switch. Either a vacuum is left or the unit filled with chemically inert liquid or gas, which also may be utilized to smother the arc produced on breaking high-current inductive circuits. As many machines must operate under conditions where they receive little or no maintenance, dependability of electric con-



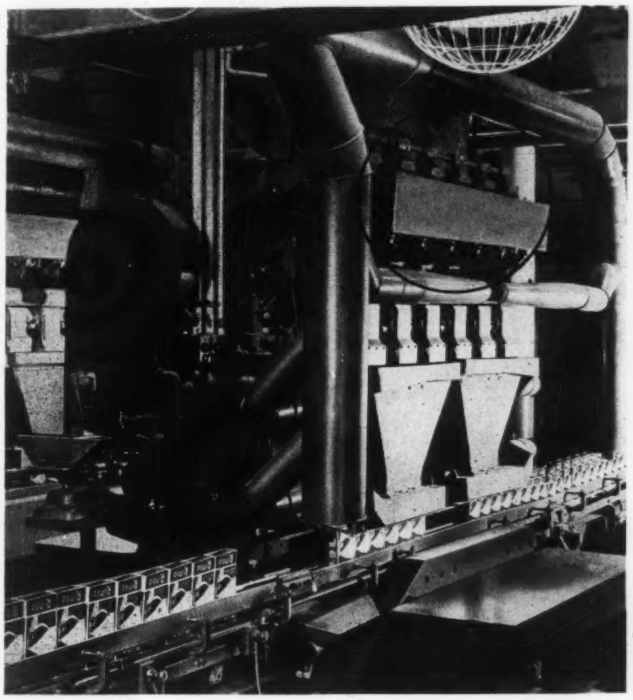
Plugging operations for reversing rotating shears on cloth selvage trimming machine are initiated by tilting two mercury switches, one normally closed and the other normally open. Reversing allows sewed seams to pass without being cut



Automatic sequence control circuits for animating displays etc. Compact, dependable means for making and breaking a large number of circuits is provided by adjustable lugs tacts is of utmost importance for continued service.

From the design standpoint, simplicity and ease of application are important advantages. The switch is tilted to open the circuit and returned to close, the same unit serving for normally open or normally closed operation. Few parts are necessary to actuate the unit. In many cases, it can be mounted on a machine member and operated by the movement of that member, thus involving no separate mechanism whatever. Mounting mercury switches also is simple as they usually are held in a spring clip fastened to the actuating member. The small size and compact arrangement possible are further features. For ordinary control applications, only a few inches need be allowed for the switch.

Amount of motion required for operation depends not only upon the type and design of the switch, but also upon the rapidity of the motion. On slow motion, the minimum operating angle may be anywhere from ½ to 5 degrees. On rapid motion it may run up to 15 degrees. The minimum operating angle varies greatly with character of application and frequency of the make and break.



Volume and weight of powder in each package is controlled by heavy duty mercury switches in automatic packaging machine, left. Two-ampere, direct-current, inductive load circuit is closed and opened twenty-seven times a minute

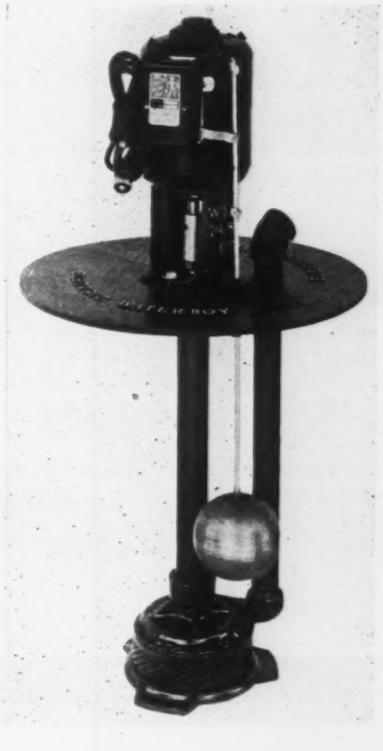
Throw Provides Snap Action

In applying mercury switches, however, positive throw from the closed to the open position and vice versa should be provided wherever possible. This permits the full use of the "snap" action inherent in mercury switches. Nevertheless their ability to operate successfully with motion so slow as not to be discernible to the eye is often useful. Under these conditions, a mercury switch functions well because of its inherent characteristic of separating the mercury into two round surfaces where the pool is broken. In equipment utilizing slow-motion controls, provision should be made for minor adjustments when changing switches. Often small variations in case or housing structure may change the angle of make or break slightly.

Positioning of any mercury switch is important, due to the influence of gravity upon action of the mercury and sensitivity of the mercury pool to vibration. Machines which are mounted permanently will have no difficulty from this point. This element, however, must be considered in application to portable equipment. Many portable machines are called upon to operate in a number of positions. This must be duly considered when designing the particular control to be applied.

Automatic Protection If Machine Tips

This characteristic can be a decided advantage in certain types of equipment where a mercury switch can be employed to prevent operation in position other than that intended. For instance, a vacuum cleaner may have a mercury switch mounted in the handle in such a manner as to prevent operation unless it is in an upright position. In a similar manner, machines can be arranged to shut down automatically if they are tipped over.

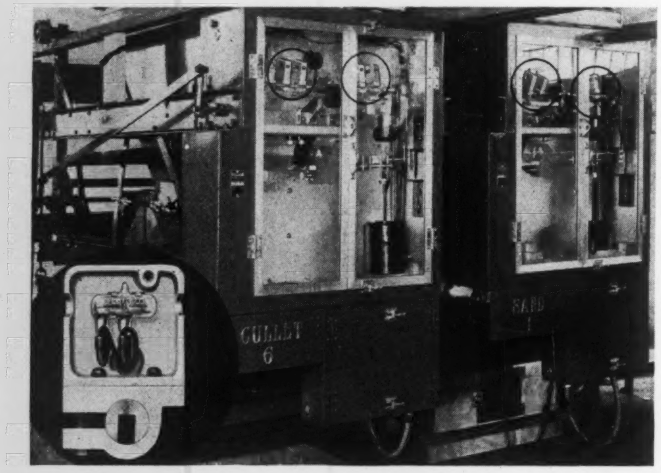


Float controls are particularly suited to operation by mercury switch. Mounted directly on motor, switch is operated by lever movable up or down according to float

Assurance of perfect operation over long periods of idleness is a feature of mercury switches frequently justifying their use. Being hermetically sealed and completely protected against contact corrosion, frequent operation of the contactor is not necessary to assure continued satisfactory performance.

The low amount of power required to operate a mercury switch is an important advantage on certain types of applications. Many automatic controls such as bimetal thermostats operate more efficiently and reliably when little energy is required for the contact-making operation. Since a mercury switch can be pivoted just slightly off center, it can be operated on extremely low amount of mechanical power. Especially in automatic switching, power is usually limited.

Where it is necessary to keep power required to operate the switch to an absolute minimum, designers should use highly flexible connections. Some applications have required more power than allowed due to that needed to flex excessively stiff connecting leads. By specifying properly braided flexible connections, however, resistance to flexing can be kept to a minimum.



Blending and volume control in automatic weighing machine are governed by eight built-in mercury switches operated by weighing beams

With mercury switches, there is no noise of opening or closing contactors. This may be important in office machines and other equipment where every means must be employed to keep down noise.

In general, mercury switches can be divided into two types—those with mercury-to-metal contacts and those with mercury-to-mercury contacts. The electrode-to-mercury type of switch is usually more suitable for low-angle applications where satisfactory operation is desired with small movement. Many thousands of switches have been produced in which the angle of operation is consistently maintained at less than one half a degree. This type of switch also is most suitable for low current values, possibly not exceeding 10 amperes at 110 volts.

Have Long Life

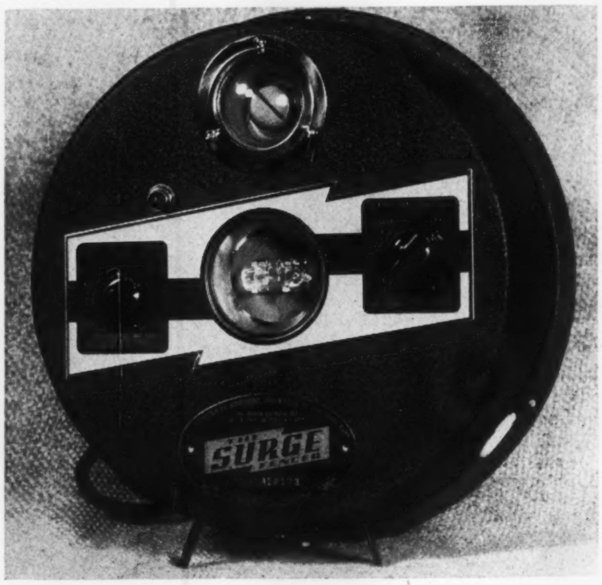
Mercury-to-mercury type is suitable for high current values up to 200 or 300 amperes, and considerable development work has been done on units with much higher capacities, a number already being in service.

Life of mercury switch, assuming it is used within its rated capacity, is usually in millions of cycles. On the other hand, a mercury switch may be justified for one operation in ten years. Service conditions greatly effect operating life. A large number of mercury switches employ glass tube enclosures which of course are subject to breakage. Ample mechanical protection must be provided for this type. Metal-enclosed and all-metal switches are widely used.

Mercury switch ratings are more complex than is understood generally. They are affected to some extent by circuit voltage and to a considerable extent by differences in performance of direct and alternating current. These units have higher inherent capacity on noninductive loads than on loads that are inductive.

Ratings Vary According to Load

Any one switch may have several ratings which are a function of current and voltage rather than wattage. For instance, a single switch may have an interrupting capacity at 125 volts of 20 amperes direct current and 25 amperes alternating current. At 250 volts this is reduced to 10 amperes direct current and 20 amperes alternating current. While not recommended for 550-volt direct-current service, it has an interrupting capacity of 15 amperes on alternating current at that voltage. The same unit is not recommended at all for direct current use on inductive loads, but is rated 25 amperes alternating current at 125 volts, 20 amperes at 250 volts, 15 amperes at 550 volts. Similarly, while this same unit will handle a 1-horsepower direct-current motor at 125 or 250 volts, it is not recommended for split-phase alternating-current motors over ¼-horspower. The same switch can be used for 2 or 3-phase alternating-current motors up to 550 volts and 5 horsepower.



High tension impulses on fence wire is obtained with this unit. Mercury switch is rocked by synchronous motor to intermittently open and close primary circuit. Switch has curvature in tube to prevent maintained contact even if oscillations stop

Dimensions of a mercury switch are to some extent in proportion to its current-handling capacity. A unit 1-inch long and ¼-inch in diameter may have a capacity of only a fraction of an ampere, while a switch 3 or 4 inches long may carry 25 to 50 amperes, with larger units in proportion. Main cross section

Fundamental Application Data on CAPACITOR MOTORS

Number Two of a series on "How to Select a Small Motor for your Machine"

The purpose of these articles is to give the engineer or designer basic information that will help him in applying fractional-horsepower motors to his products. The previous article dealt with the split-phase motor. Other commonly used types of motors will be considered in future articles. All these types of motors and many others are available in the standard Bodine line.

Capacitors may be used with single-phase motors for starting only or for both starting and running. By definition, the capacitor motor is of the latter type, in which the capacitor is connected to the motor at all times.

Common Uses

The capacitor motor is most frequently used on air conditioning equipment, control apparatus, and many other machines not requiring high starting torques, where utmost reliability is essential.

Principle of Operation

There are two windings in a capacitor motor. One has a capacitor permanently in series with it. This creates a phase difference between both windings, producing a rotating field which provides the motor with starting torque and drives the unit much like a two-phase motor. The capacitor may be mounted on the motor or at a distance from it.

Limitations

The starting torque of the capacitor motor is generally less than the full-load torque. Hence, where the load requires a high torque to start, the capacitor motor is not suitable. They are also more expensive than certain other motors.

Advantages

The absence of cut-out switches, commutators, and slip rings accounts for the exceptional reliability of capacitor motors, as well as for the fact that the motor does not interfere with radio reception. Capacitor motors are also very quiet in operation. There is less vibration than in ordinary single-phase motors, because they develop a more uniform torque. Power costs are kept low because of the high power factor and good efficiency. The motor can be operated at lower than normal speeds, particularly on fan loads because it can be designed for high slip.

Cut-away view showing a Bodine capacitor motor with built-in speed reducer drive.

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of the mercury pool determines its current-carrying capacity. There must be sufficient space within the switch to allow a complete and safe separation of the mercury to provide a positive break for the current and voltages to be handled.

Switches for time-delay applications have been developed, utilizing interior baffles with small orifices which give the time-delay characteristics desired. Such a switch will provide quick make and a slow break or quick break and slow make in a variety of timings and current ratings. Delayed timings up to 15 seconds are quite common, with even greater delays possible. Perhaps the greatest limiting factor in application of time-delay mercury switches is that they must be tilted through rather large angles for proper operation.

Glass-type mercury switches provided with fish-spine beaded leads and high-temperature insulating cement have been used successfully in ambient temperatures as high as 350 degrees Fahr. An oversize switch should, of course, be employed if operation is frequent at these high temperatures. Generally speaking, cotton-covered leads should not be used when ambient temperatures rise over 180 degrees.

Applications Are Broad

Application possibilities of mercury switches are extremely broad as they require so little energy they can be operated satisfactorily from thermal elements, gas-operated wafers or bellows, as well as solenoids, motor-driven cams, toggle or snap-action mechanisms and similar devices where considerable power is available.

In general, the switch can be operated by any means which will afford the change required to shift the position of the mercury. It may be connected to a depressable platform moved by hand or foot or some mechanism.

A simple illustration of elementary application methods is found on an assembly bench where an operator using an electric screw driver suspended from an overhead arm was able to turn the screw driver on and off automatically simply by mounting a mercury switch on the movable arm of the counterbalance which lifted the screw driver out of his way when not in use.

Use Determines Tilt Angle

Thermostats may use a mercury switch actuated by a small metal bellows filled with volatile liquid or bimetal. Such units will function on a tilting angle as small as one half angular degree to operate on a temperature differential as low as 1 degree Fahr.

In portable instruments employing mercury switches which operate on extremely small angles, it is necessary to make some provision for leveling the machine. This leveling can be accomplished easily by lining up a free-swinging pendulum with reference marks stamped on the unit. Portable machines which cannot readily be leveled each time they are moved should have sufficient angular throw provided in the mercury switch so minor off-level positions of the machine caused by irregularities in floor level will

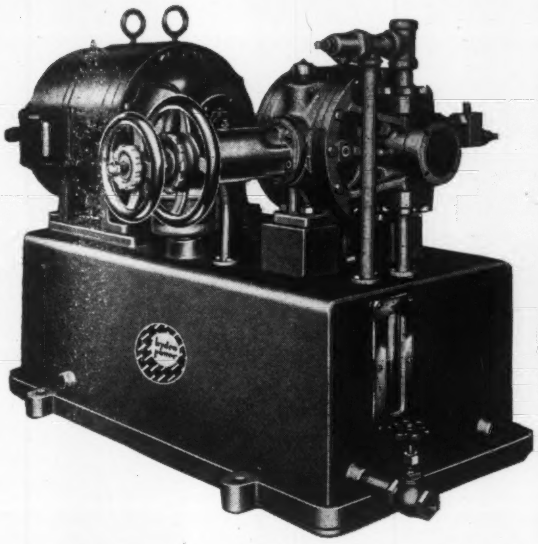

Figure 5221—Single radial pump unit with both volume and pressure control for high pressure service.

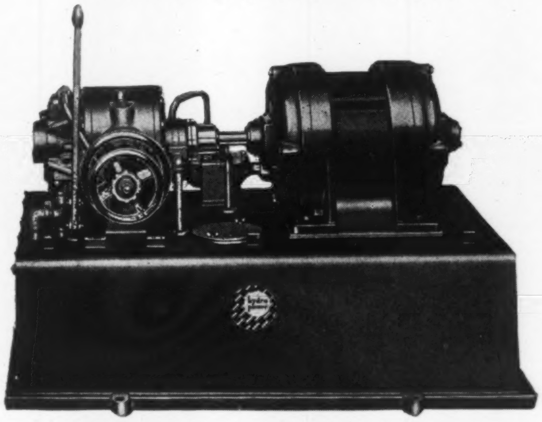

Figure 5309-A—Single radial unit complete with operating valve for high pressure service.

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2. Single Gear Pump Units
3. Combination Radial and Gear Pump Units

SPECIFICATIONS OF HYDRO-POWER SINGLE PUMP UNITS:

	RADIAL UNITS	GEAR UNITS
Type of Pump	Piston Type	Gear Type
Pump Delivery	Variable	Constant
Max. Working Pressure (lbs./sq. in.)	2500	1000
Pump Output (gals./min.)	1¼ to 23	5 to 35
Pipe Connections	Flanged Type	Flanged Type

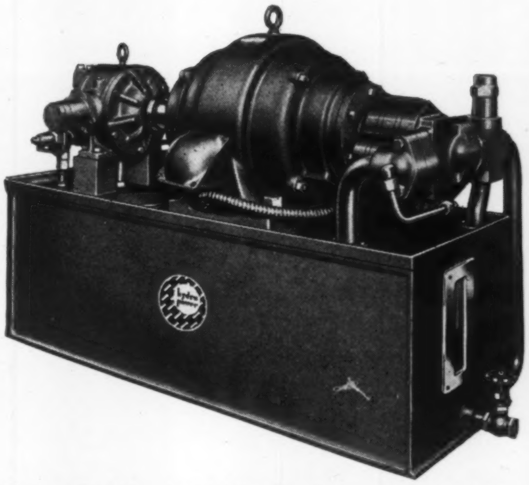

Figure 5174-E—Combination Gear and Radial two-stage unit. Heavy duty gear pump flanged directly to end of motor. For medium and high pressure service.

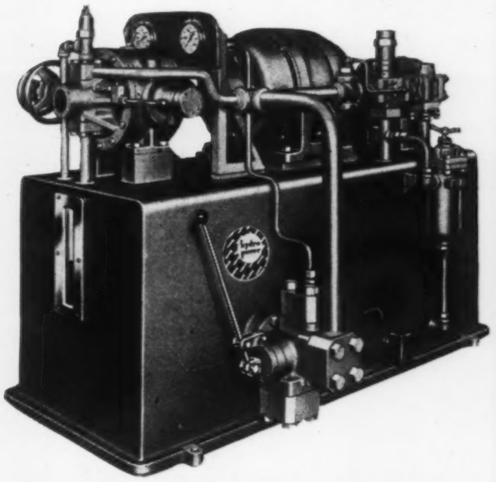

Figure 5044—Combination Gear and Radial two-stage unit with operating valve for medium and high pressure service. Double-end shaft motor.

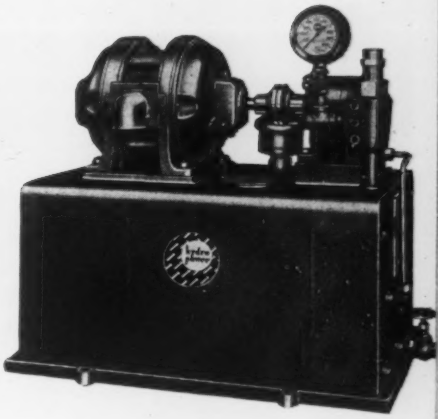

Figure 5122—Single gear pump unit with adjustable pressure relief valve for medium pressure service.

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not affect positive operation of the switch. Machines involving some vibration also should utilize a switch operating through a wide angle to prevent unwanted operation of the switch. Excessive vibration can throw droplets of mercury against contacts.

Possibly one of the more severe applications for a mercury switch is in a drink or cocktail shaker operated automatically by an electric solenoid, giving it a vertical action. A small mercury switch rigidly mounted at a protracted angle on the moving head operates the machine by inertia. The switch acts like a vibrating contact, causing a shaking action to occur 800 times a minute. This is extremely severe service as load is approximately 3½ amperes and is highly inductive.

Considerable testing equipment has been built using mercury switches to repeat automatically certain sequences or cycles of operation desired.

Hermetic seals also afford protection against explosion when the equipment is to be operated in explosive atmospheres. Even where explosive conditions do not exist, hermetically sealing the electric contacts is an added protection against fires.

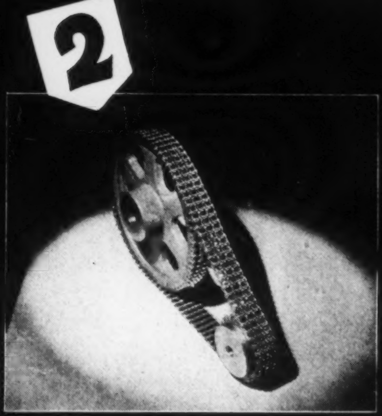
Moisture and Dirt Have No Effect

Many automatic vending machines employ mercury switches. For instance, one machine utilizes a 1-ampere mercury unit mounted on the bottle trap door which causes the mercury switch to open a circuit and interrupt a small relay, stopping the motor which operates the turntable when a bottle is ejected. The switch in this case is superior to any kind of mechanical contact mechanism as considerable moisture and dirt are encountered. Its dependability is important since should the contact fail to operate, the machine would continue to eject bottles that had not been paid for.

In the illustrated application of the mercury switches on the high-speed cotton shearing machine, selvage threads are trimmed from cotton cloth at speeds up to 110 yards a minute. Cloth from the looms, in lengths of 80 to 120 yards are sewed together end to end before passing through the shearing machine. Seams must be protected when going through the machine. Otherwise they would be cut in two. This protection is secured by reversing the direction of rotation of the rotary shearing unit whenever a seam is passing.

Each of the four shearing units on the machine is individually motor-driven, and the motors are plugged to reverse the direction upon the approach of a seam and replugged to shearing direction when the seam has passed the cutters. The two plugging operations are automatic and are obtained through a timing device which carries mercury switches, one normally closed and the other normally open. These switches operate a magnetic switch reversing direction of motors.

Co-operation of the following companies and useful material supplied by them is gratefully acknowledged by MACHINE DESIGN: Brown Instrument Co., Durakool Inc., General Electric Co., Jefferson Electric Co., The Mercoid Corp., Minneapolis-Honeywell Regulator Co., and Struthers-Dunn Inc.



How shall I rig up that drive?

1

SPEED REDUCERS

In olden times speed reducers were practically unknown and when a large ratio of reduction was required, one had to resort to a complicated train of open gearing that was cumbersome, noisy and a constant threat to life and limb. To overcome these objections, inclosed gearing or speed reducers were gradually developed until at the present time, the modern speed reducer or motorized speed reducer is in fact a finished machine designed and built to economically, quietly and safely provide almost any required ratio of reduction.

Boston Gear Works, Inc. offers a wide selection of over 600 ratios, types and sizes of modern speed reducers and motorized speed reducers, 95% of which are carried in stock ready for immediate use.

2

CHAIN DRIVES

In every day parlance or in the mind of "the man on the street," chain drives are commonly thought of as being used on bicycles and on motor trucks, but in the mind of the industrialist, chain drives play a very important part in the transmission of motion or power between parallel shafts.

Chain drives are flexible, they are positive, they are up to 98.5% efficient, and they are admirably suited for drive conditions requiring speed reduction ratios up to 6 to 1.

Boston Gear Works, Inc. offers a complete chain drive service ranging from "flea" power to one hundred horsepower. Then too, chains and sprockets for these drives are carried in stock ready for immediate shipment.

3

SPUR GEARING

Spur gears have been used from earliest times with but little change except in the matter of refinement and today they are used more frequently than any other type of gear. At one time spur gears with cast teeth were used quite extensively, but due to the constant cry for more power, speed and efficiency in the modern machines, this type of gear has been displaced by machine cut gears which use less power and operate with less noise and greater efficiency.

Boston Gear Works, Inc. offers a complete line of machine cut stock spur gears ranging from 3 to 48 diametral pitch and in sizes from less than ¼″ up to 40″ in diameter.

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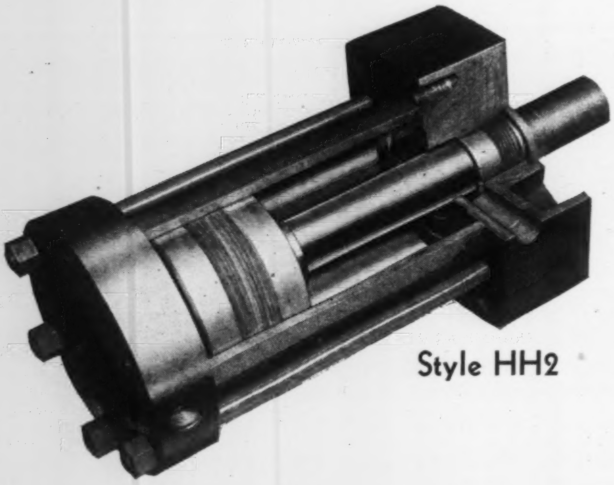

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Catalog H-37 reports on additional construction features, service characteristics and gives complete cylinder specifications. Your copy also includes important usable data on hydraulic installations and will be sent promptly. Address The Tomkins-Johnson Co., 618 N. Mechanic Street, Jackson, Michigan.

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Simple Controls Provide Wide Work Range

(*Concluded from Page* 26-S)

from the motor to the transmission give an efficient and quiet drive.

The spindle is mounted in a basket type frame having a spherical seat in the housing at the top, as *Fig.* 4 shows. Some lateral adjustment is provided at the bottom, permitting precision alignment with the column without excessive and expensive fitting in the final assembly. The unit is then locked in position and if necessary can be removed and replaced.

The hydraulic system used is the result of considerable investigation. Several circuits were devised and discarded in turn in an effort to eliminate complexities and the system shown schematically in *Fig.* 5 was selected for its simplicity. A variable delivery pump with automatic pressure regulation and driven by the main motor supplies the system. Feed control valves are all of the metering type and are installed to meter the exhaust. Two valves are included in the turret circuit giving the choice of two feeds, while one feed was considered adequate for the side head.

Lines Pass Through Solenoids

By referring to the current circuit in *Fig.* 5 it will be seen that both cylinder lines pass through a four-way solenoid valve, the line to the return side of the cylinder being direct. The line governing the downward or working speeds is branched into a double loop, each loop including a metering valve and a normally open two-way solenoid valve. On a downward movement of the turret, if both valves are de-energized, a free passage back to tank is open. Should the coarse feed valve be closed the exhaust is forced to return through the metering valves. If the fine feed valve is closed, both loops are cut out and the flow of oil is restricted to the fine feed metering valve.

The machine is made in three sections, a lower section or sub-base of welded steel, a middle section or main base of cast iron and the upper section or main housing of welded steel, all shown on end in *Fig.* 6. Welding of the housing and sub-base eliminated pattern costs, afforded a better surface for finish, and allowed the placing of jointless pipes and conducts for the hydraulic, electric and coolant lines within the structure. This construction also permits inexpensive changes in design for improvements or special features, and in this particular case allowed integral fabrication of the tanks for the hydraulic, lubrication and the coolant systems. Another study of *Fig.* 4 will reveal that the main drive motor, hydraulic pump, valves, piping, and tanks are located in the sub-base. Change gears, back gears, spindle and valve control mechanism for the turret are mounted on the main base plate or middle section. The upper housing holds the column, turret guide pins, side heads and the upper portion of the spindle housing.

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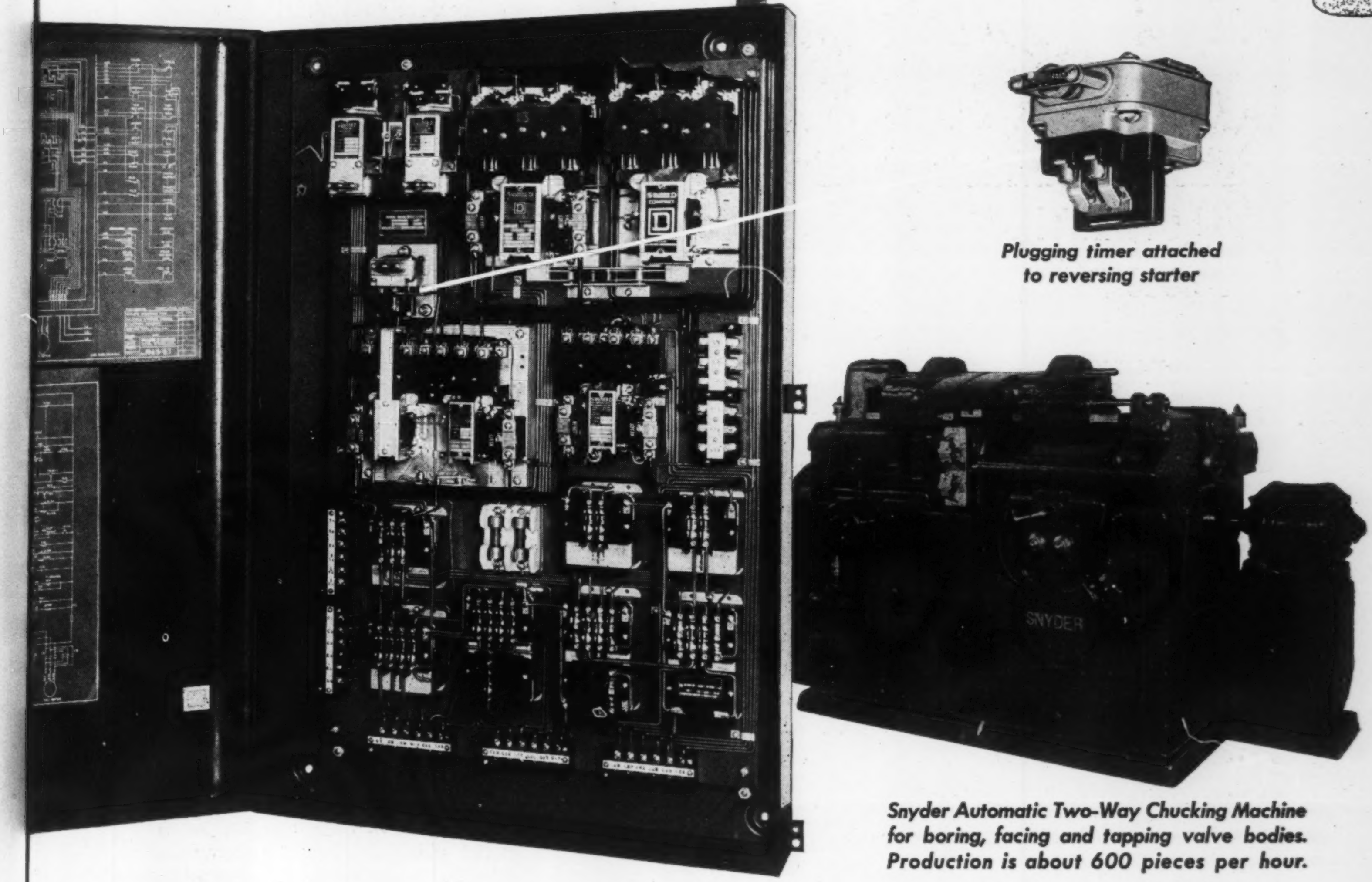

Plugging timer attached to reversing starter

Snyder Automatic Two-Way Chucking Machine for boring, facing and tapping valve bodies. Production is about 600 pieces per hour.

● This Square D control panel synchronizes and electrically interlocks the head and index motors, the hydraulic feed, and the air operated fixture wrenches, giving full automatic control to this drilling, spot facing and tapping machine.

Of special interest is the Square D timer which governs the plugging of the index motor. Upon completion of the indexing motion, it energizes a reversing contactor just long enough to bring the motor to rest. This eliminates plugging switches or solenoid brakes and reduces installation costs. The accuracy and dependability of this timer has been proven in a wide variety of similar applications.

Square D field engineers are glad to cooperate with the users or manufacturers of machinery in solving control problems. Write for Bulletin 151, showing interesting machine tool applications, or

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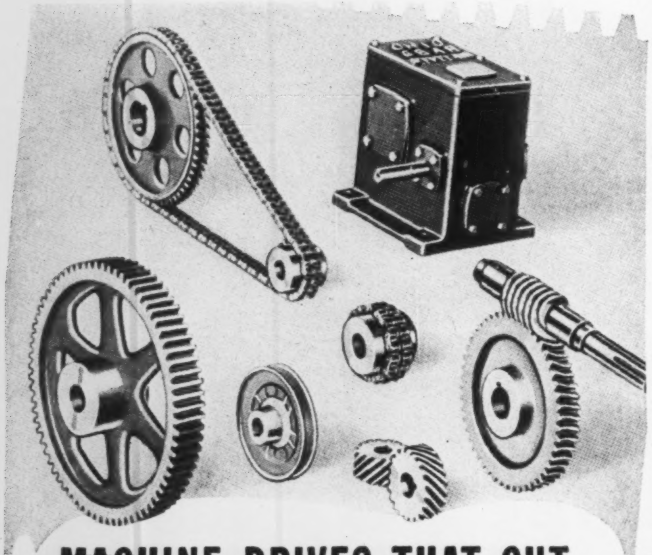

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OHIO GEARS

Internal Combustion Engines Applied to Machines

IN SELECTING an internal combustion engine for a particular drive application, factors of relative weight, physical size and operating flexibility should be given as much consideration as the type of fuel utilized. Other features which influence selection include ample reserve power, range of speeds, availability or maintenanace factor, and sufficient flexibility to perform at speeds and power required.

Indicative of the wide selection of engines available, the following table lists a few characteristic types of gasoline engines both two and four-cycle, air and watercooled and diesel engines, two and four-cycle.

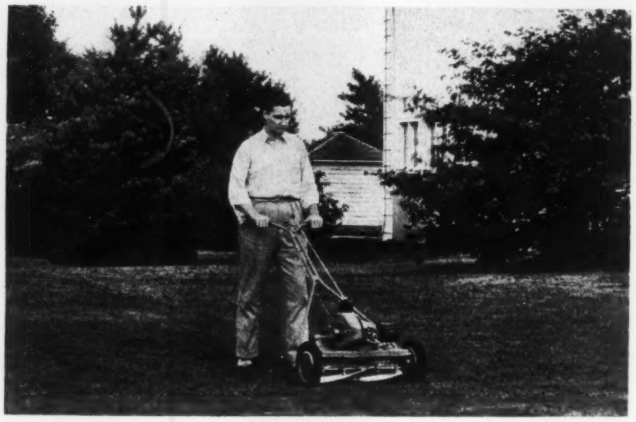


Fig. 1—Fractional horsepower, two-cycle gasoline engine furnishes ample power for lawn mower. Entire unit weighs only 115 pounds

Engines are economical in operation, the type of service and location usually determining whether gasoline, oil or gas is to be used for fuel. For operation in remote locations or where extreme flexibility is desired, the internal combustion engine is unequaled.

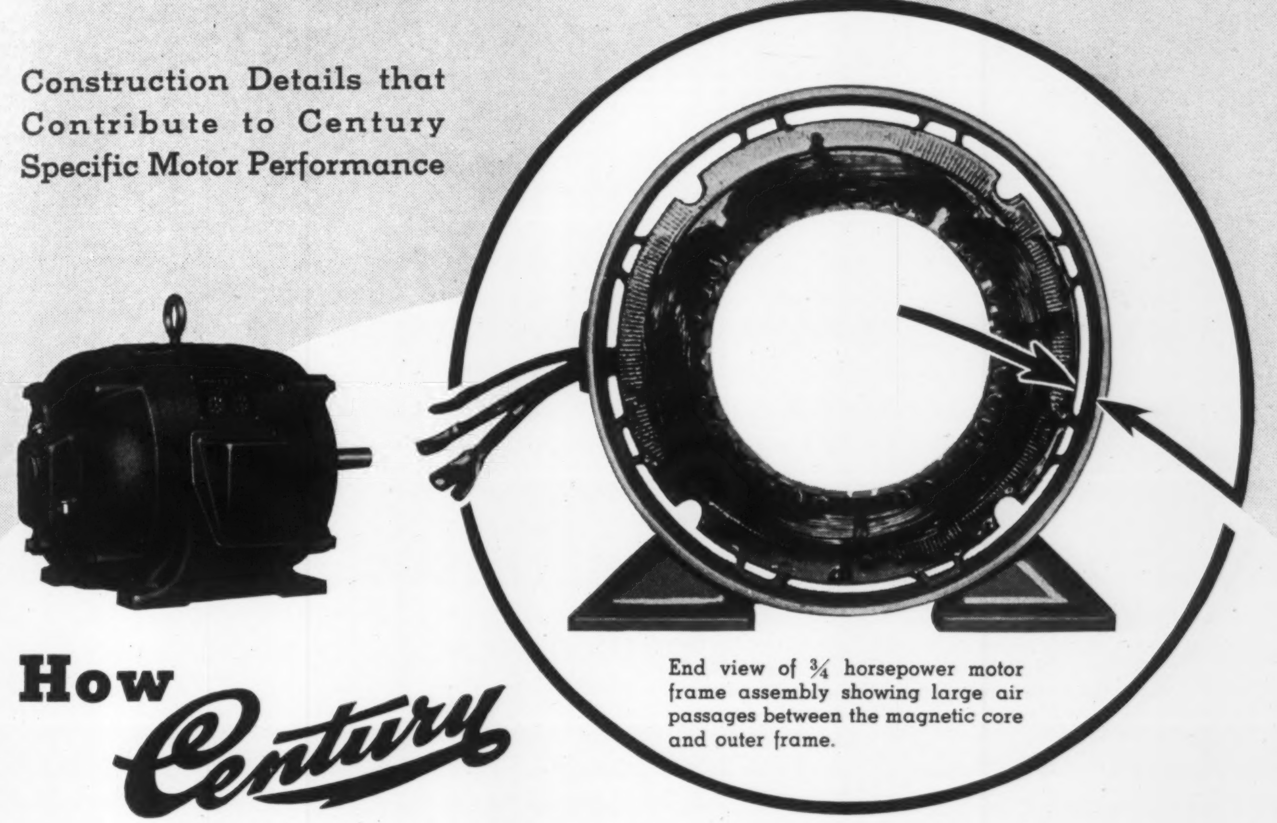
Careful study is necessary in applying an engine and in selecting its size. For direct-connected drive the coupling besides having sufficient rating and flexi-

Characteristics of Typical Engines

Engine Type	Cylinders No.	Speed R.P.M.	Power H.P.	Torque Ft.-lb. max.	Weight lbs.
Gasoline	1	1100-1800	1.2-2		78
air-cooled					
2-cycle					
Gasoline	1	1200-2400	2.3-4.2	10.4	125
air-cooled	1	1200-2000	3.9-5.4	17.1	170
4-cycle	4	1200-2200	21-31	79.2	340
Gasoline	4	500-2500	6-26	62	305
water cooled	6	600-2400	18-70	170	610
4-cycle	6	600-2400	38-130	350	1370
	6	600-1200	120-210	1030	3750
	12	600-1200	235-415	2080	5300
Diesel	1	600-1600	7-19	87.5	875
2-cycle	4	600-2000	40-110	350	1650
	4	600-2000	42-122	525	2000
Diesel	4	450-1000	35-71	450	4300
4-cycle	8	450-1000	80-180	1000	8000
	8	750-1200	340-565	2520	8360

CENTURY DESIGN DATA

Construction Details that Contribute to Century Specific Motor Performance



End view of ¾ horsepower motor frame assembly showing large air passages between the magnetic core and outer frame.

How Century

Ventilated Core Design Assures Positive Ventilation . . . Improves Heat Radiation

The large ventilated magnetic core area, illustrated above, is another design feature that contributes to the unusually dependable performance and long life of Century Motors.

This is not a common feature in small motor design. Both small and large Century Motors have this ample ventilated air space between the active magnetic material and the outer frame. This feature, together with a large properly designed fan, guides a positive flow of cooling air over the surfaces of the windings and magnetic core, thus reducing the danger of hot spots and consequent quickening deterioration of insulation—means dependability—longer life.

This is only one example of the many reasons why more and more manufacturers are taking advantage of Century Performance when they select motors for all types of motor driven equipment.

Century Motors are available in a wide range of types and sizes from fractional to 600 h.p. As a result there is a correct Century Motor to meet the requirements of practically any driven machine. And when the motor fits the job, performance is improved, costs are kept down.

It will pay you to find out more about the design and construction of Century Motors. Your nearest Century Motor Specialist will gladly give you full information on the advantages of standardizing on Century Motors for *your* applications. Call him in today.

CENTURY ELECTRIC COMPANY
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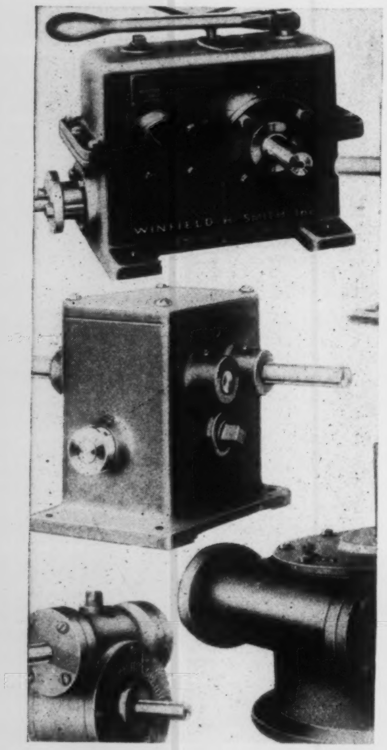
FOR EVERY NEED



Bring your speed reducer problems to us. We have the most complete line available from any one source . . . and 90% of orders for WHS standard stock speed reducers are *shipped the same day!* In addition, our engineering staff is constantly advising on

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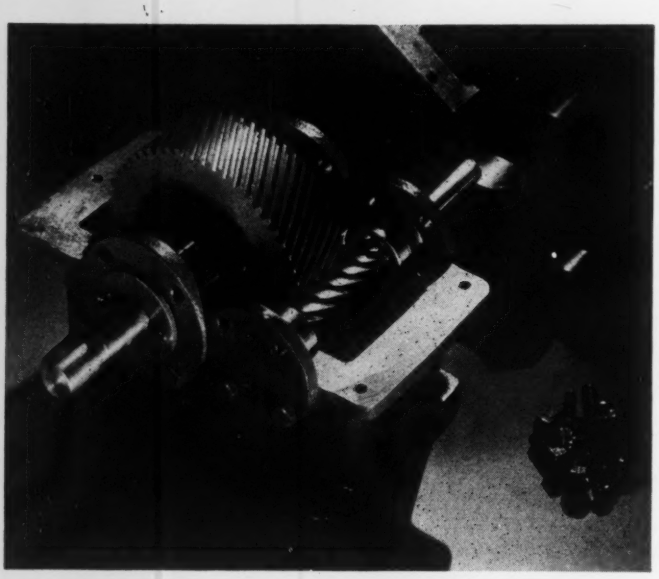

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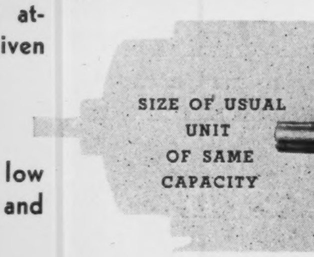


WINFIELD H. SMITH, Inc.
A Speed Reducer for Every Application
16 ELTON STREET, SPRINGVILLE, ERIE COUNTY, N. Y.
Established 1901

bility, should be so selected to smooth out the torque impulses delivered by the engine. Mounting, of course, must be sufficient to maintain alignment under all operating conditions and so designed as to absorb the required degree of vibration. More engine cylinders naturally provide smoother power. For this reason, the two-cycle engines are receiving considerable attention. Each piston of this type of engine delivers power on each downward stroke. Another noteworthy feature is the fact that piston members are not subject to severe reversals of stress and as a result pounding of bearings is reduced.

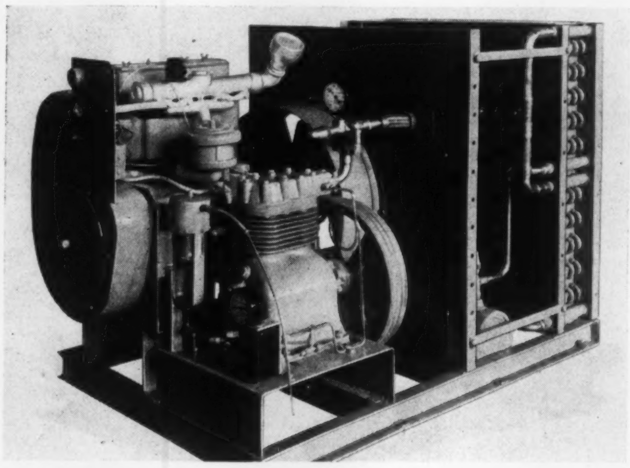


Fig. 2—Air conditioning unit for private railroad car is powered by four-cylinder, aircooled engine. Automatic starting is controlled by thermostat

Smaller ratings of gasoline engines are being applied extensively to portable wrenches, grinders, drills and other tools such as used for railway maintenance and work, to lawn mowers, rollers and to small snow plows. *Fig.* 1 illustrates an application to a lawn mower. The power plant is two-cycle, ¾-horsepower, aircooled unit with no major moving parts other than piston, connecting rod and crankshaft. Control is from operator's handle through flexible shafting for both clutch and throttle operation.

Air conditioning units as shown in *Fig.* 2 are economically powered by internal combustion engines ac-

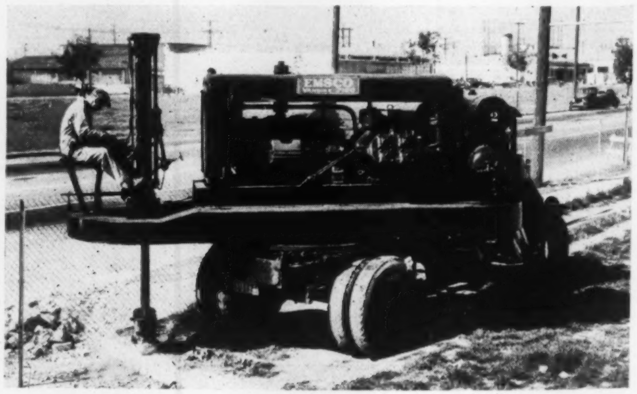
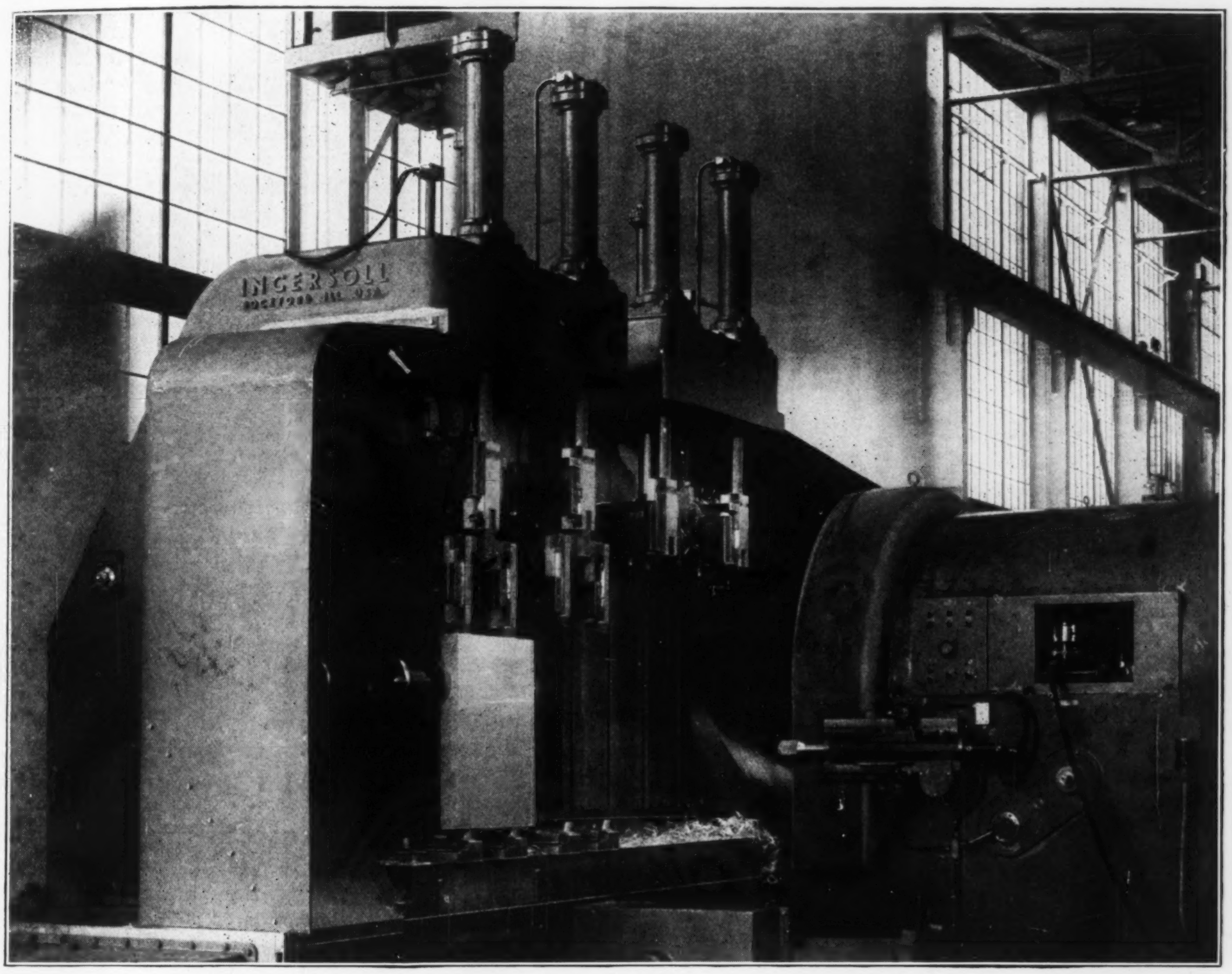


Fig. 3—Two-cycle diesel on pavement breaker is light in weight and responds quickly to varying loads



Ingersoll aluminum slab scalping machine equipped with Hannifin Hydraulic Cylinders

HANNIFIN HYDRAULIC CYLINDERS

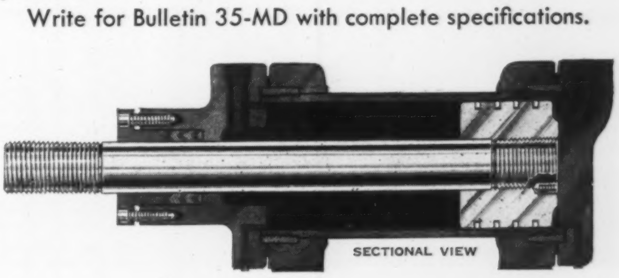
built to match modern machine tool construction

Hannifin patented high pressure hydraulic cylinders make the advantages of hydraulic power more readily available. Their simple design, with universal end caps and a variety of standard mountings, makes application easy and simplifies piping and control. Precision construction with honed cylinder bores means high efficiency operation—minimum fluid slip and maximum usable power.

Hannifin no-tie-rod design results in a stronger, simpler cylinder assembly and allows removal of end caps without collapse of other parts. End caps may be positioned independently, with inlet port at top, bottom, or either side. Each end cap has air vents on three sides. Hannifin mirror finish honing produces a straight, round, perfectly smooth cylinder bore, affording high efficiency piston seal with minimum fluid slip.

Hannifin hydraulic cylinders are built in six standard mountings, with small diameter piston rod, 2 to 1 differential piston rod, or double end piston rod, with or without cushions. All sizes, for working pressures up to 1000 and 1500 lbs. per sq. in. Other types built to order, any size, for any pressure.

Write for Bulletin 35-MD with complete specifications.



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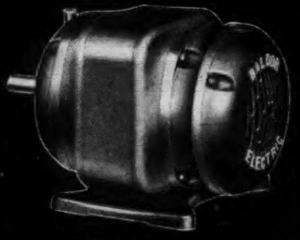

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OF KNOWING HOW

Since 1920, the name BALDOR has been associated with only the Better Motors.

For 20 years, Baldor has specialized in building motors to meet the special requirements of manufacturers of all types of machines, tools, and other motorized equipment.

For 20 years, Baldor has pioneered and developed some of the most important advances in motor design and construction, including the New STREAMCOOLED Design and GLASS-INSULATED motors.

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BALDOR
BETTER MOTORS

cording to their capacity. This unit designed for a private railroad car is driven by a four-cylinder, air-cooled gasoline engine equipped with automatic starting controlled by a thermostat. Drive is through an automatic centrifugal clutch mounted direct on engine shaft with condenser cooling fan.

Diesels are considered to operate best at from two-thirds to full continuous rating. Intermittent loads at maximum horsepower are permissible for most applications provided such periods are of short duration. In *Fig.* 3 is shown a two-cycle diesel operating a pavement breaker. Two important considerations in this application were light weight of engine and fast response to varying loads.

Convertible engines of the Hesselman type, operable on gasoline, oil or gas, are particularly suited to contractors' equipment and oil field work. They are useful for the former because relative prices of fuel vary in different sections of the country and the latter because after drilling is completed free gas fuel may be used. The shovel, *Fig.* 4, is powered by a 180-horsepower compression-ignition engine. This type of engine is smooth running and flexible as to speed and acceleration. Its characteristics parallel gasoline engine performance.

Fig. 4—Compression-ignition oil engine on this shovel has operation characteristics of gasoline engine

An interesting application to rotary tables for oil well drilling has a convertible engine. Instead of the usual friction clutch, drive is through an hydraulic torque converter. The converter output shaft is connected to a step-up gear with a flexible coupling of the enclosed type on the input shaft and a flexible coupling of the chain type on the output shaft of the gear box. This type of drive is chosen because both the torque and speed requirements of the rotary vary over a wide range. In most applications of this kind, the engine is operated on available natural gas.

Another interesting engine developed recently utilizes crude oil as the fuel. The fuel passes through settling tanks and filters before injection into the engine. Fuel injector parts are all corrosion resistant.

MACHINE DESIGN acknowledges the helpful co-operation of the following companies in the preparation of this article: Caterpillar Tractor Co.; Continental Motors Corp.; Cummins Engine Co.; General Motors Diesel Engine Division; Jacobsen Mfg. Co.; Le Roi Co.; Oil Well Supply Co.; Sterling Engine Co.; Superior Engine Division, National Supply Co.; Waukesha Motor Co.; and Wisconsin Motor Corp.

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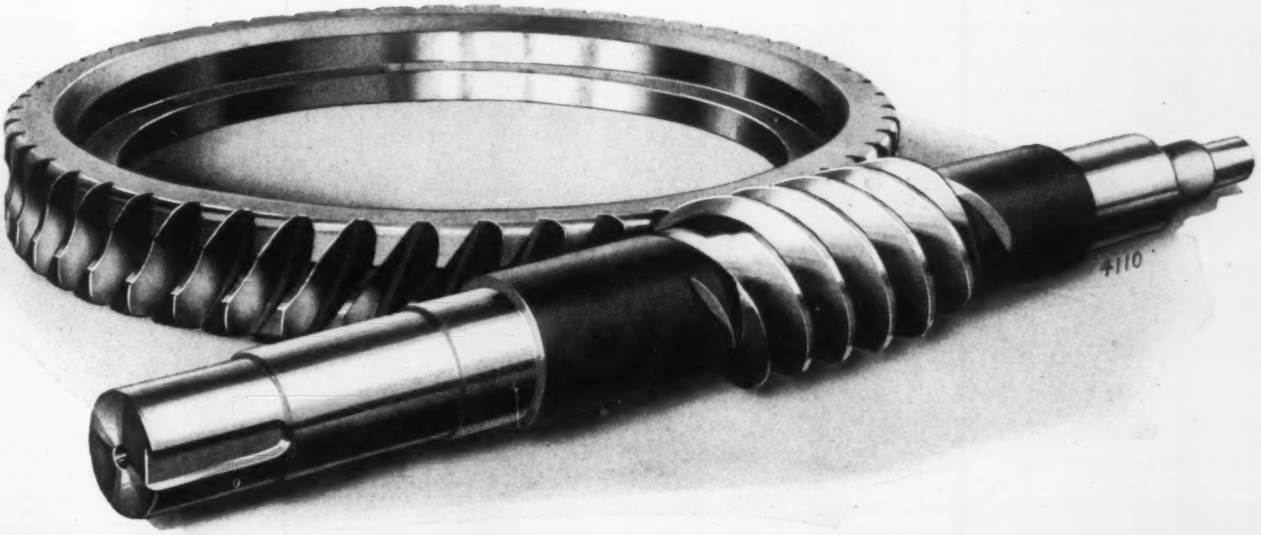

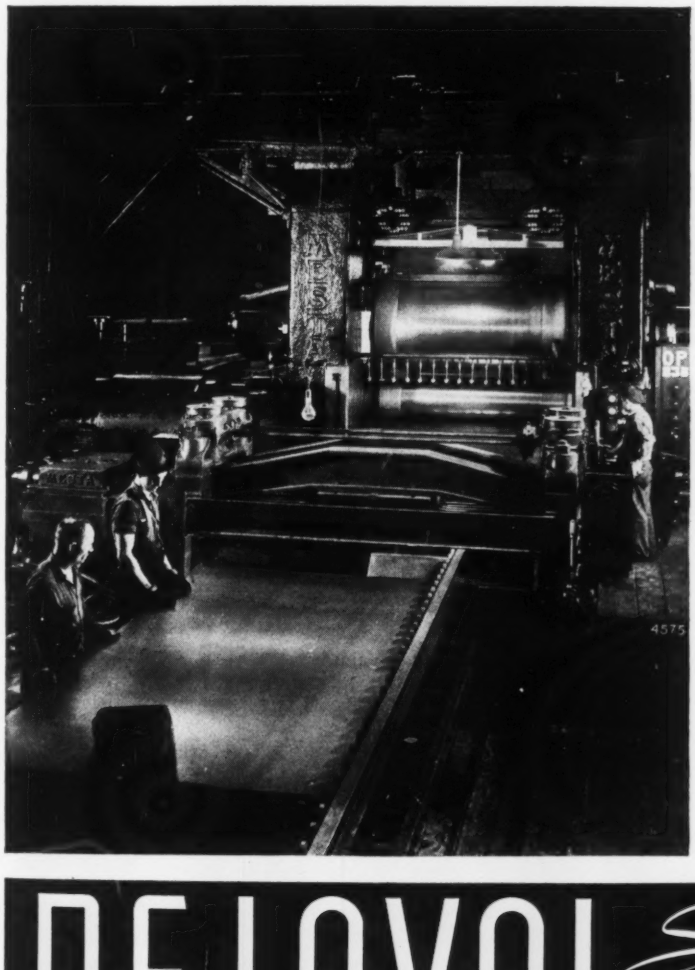

use QUALITY PARTS

THE Pittsburgh Works of the Jones & Laughlin Company was designed to produce highest quality hot and cold rolled strip and sheet steel. The photograph shows a roller leveler in operation at the delivery end of a Mesta four-high temper mill.

The screw downs are operated by

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WORM GEAR SETS

which provide great force and precision in small space for the adjustment of the rolls.

Data on worm gears and their applications will be supplied by our engineers, upon request.

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MANUFACTURERS OF TURBINES STEAM HYDRAULIC PUMPS CENTRIFUGAL PROPELLER ROTARY DISPLACEMENT MOTOR-MOUNTED MIXED-FLOW CLOGLESS SELF-PRIMING CENTRIFUGAL BLOWERS and COMPRESSORS GEARS WORM HELICAL and FLEXIBLE COUPLINGS

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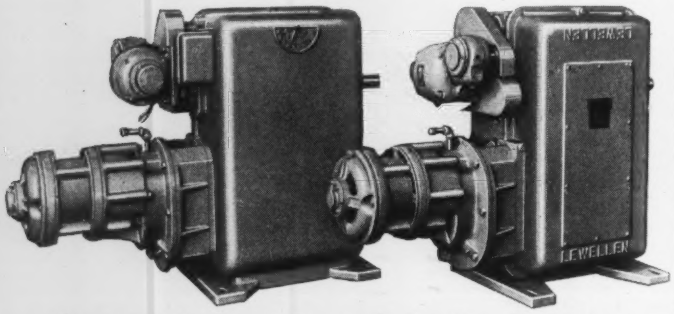

One unit controls spindle speed—the other, feed screw speed. Both units are required to operate in verticle and horizontal position during the cycle of operation.

The spindle control may be set for any desired speed. When the stop button is pressed, the spindle is reduced to minimum speed before the motor circuit is opened. Should the machine be stopped suddenly, the spindle will return to slow position before starting. Thus the spindle of this very heavy machine always starts at the slowest speed, then accelerates at a controlled rate, to the preset operating speed.

Since the operation generates a certain amount of heat, the temperature of the material increases thereby causing it to elongate gradually and slowly. The speed of the feed screw is accelerated automatically and minutely, at the rate of elongation, to maintain the operation at a constant rate.

● This is another of the many instances where flexibility, precision, and accuracy are combined in Lewellen's solution to a speed control problem. *Why not be certain that you are getting top efficiency from your production machines? With the application of Lewellen Speed Control unit costs are reduced—PROFITS INCREASED.*

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Lewellen

Variable Speed {TRANSMISSIONS
MOTOR PULLEYS

★ Lewellen knows speed control

When to Use Series Motors

(*Continued from Page* 31-S)

(2) It has high full-load and higher no-load speeds

(3) It is much smaller and lighter than any other type of motor developing the same power

(4) It has a high starting torque and rapid acceleration

(5) It lends itself to wide and flexible speed control

With these points in mind, examination of various types of applications with respect to the adaptation of the series motor to them is interesting.

The portable 16 mm. silent film projector, *Fig.* 1, requires a motor that is universal, light in weight, and subject to easy speed control. A machine of this type, being marketed all over the world, is likely to be subjected to a great variety of frequencies of alternating current and to direct current. To supply a different motor for each kind of power supply would not only be expensive but cause complex stock problems. Because it must be carried about it cannot employ an induction motor weighing 8 or 10 pounds. Finally, a wide range of film speeds must be available, and this is provided in the simplest possible manner by a series motor controlled by a compact series rheostat. On the silent projector, incidentally, the varying speed characteristic of the series motor is not detrimental because the load is practically constant, and the small speed variations encountered do not mar the quality of the projected picture.

Portable tools whether drills, shears, sanders, screw drivers or nut-runners, have two requirements met by only the series motor—light weight and universal operation. These tools must be light enough not to tire the operator, and because of prevalence of direct current and of alternating current of frequencies other than 60 cycles, they should be capable of operation on both alternating current and direct current. The motor applied must have a high rotor speed in order to develop a large output in a small frame, and it must be universal. To be sure, it must be geared down to a suitable working speed, but gearing is compact and has been developed to a high point of efficiency and dependability.

Light Weight Needed in Aircraft

Another type of portable tool, the grinder, utilizes the series motor for three of its properties: light weight, universality, and high speed. Hand grinders, *Fig.* 2, used for touching up dies and small parts, as well as lathe grinders for internal grinding of small bores, require small grinding wheels. To obtain proper surface speed for the wheels a high spindle speed is required. Hand grinders employ a direct drive with speeds up to 25,000 revolutions per minute, while lathe grinders use a belt drive for stepping the speed up to as high as 40,000 revolutions per minute.

Another field in which the series motor, though

HIGH RATIOS at Low Cost

Brad Foote

GYRO SPEED REDUCER

20 to 1 TO 7500 to 1

Efficiencies 70% to 90%

Additional Leverage

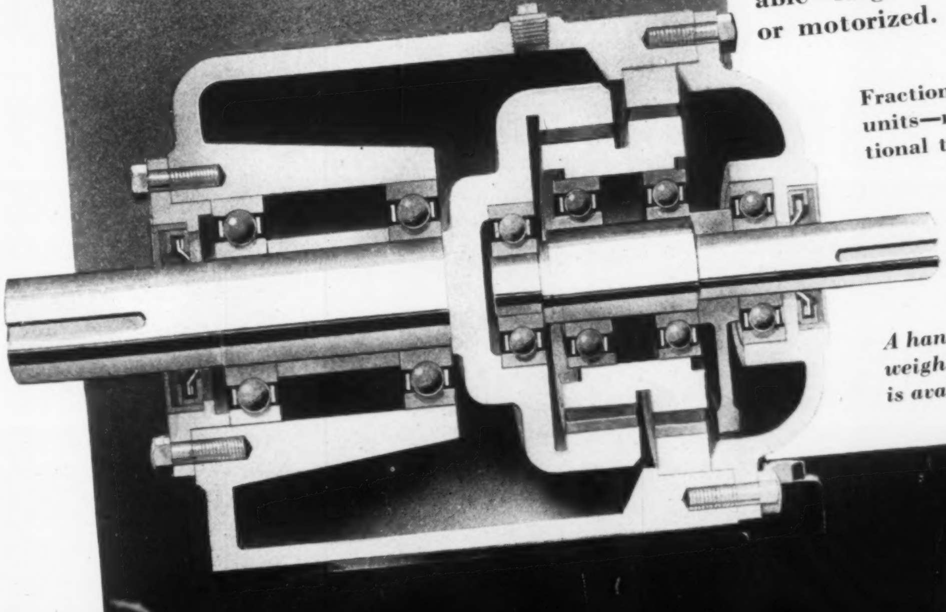
NO LARGE GEARS—

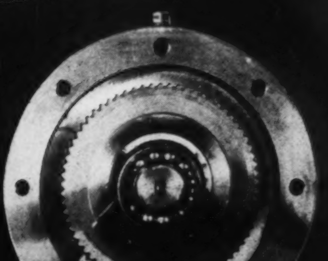
COMPACT

The New Gyro Reducer employs a principle in its design that gives *additional leverage*—Intermediate ratios and unusual torque ratings are easily obtainable—large or small—standard or motorized.

Fractional horsepower in both units—motorized from fractional to 25 horsepower.

A handbook of ratings, ratios, weights, drawings and prices is available—write.





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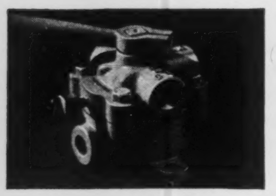
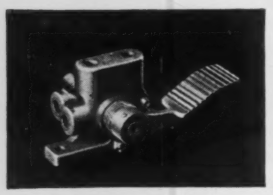
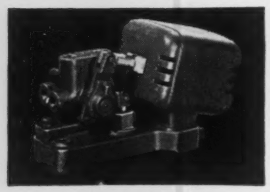


3 and 4-Way Hand Operated Valve



3 and 4-Way Foot Operated Valve with Spring "Return"



NOPAK Solenoid Valve, 3 and 4-Way, with Push Button Control

The NOPAK *packless principle* and *patented rotating disc construction* make these features *yours* at no extra cost. Air pressure against the valve disc, at all times, keeps lapped surfaces of disc and seat positively sealed, permits finger-touch operation, and prevents injury of sealing surfaces from grit or other foreign matter. The result is a leakproof valve with sealing surfaces that actually improve with use.

The packless, leakproof valve-stem assembly eliminates all packing replacements, gland-nut adjustments, maintenance or service requirements.

NOPAK Valves for Air or Hydraulic control are made in a wide range of standard sizes and models to meet practically all design applications. For detailed descriptions and technical data, write for Illustrated Valve Bulletin, No. 65.

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—are Cushioned Air Cylinders—with Adjustable Cushion-Heads for close regulation of cushion-effect . . . or with the new type Self-Regulating Cushion Head. The latter sell in the same price range as non-cushioned cylinders.

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NOPAK VALVES and CYLINDERS

not of the universal type, is finding increasing use is aircraft auxiliary equipment. The modern airplane is being electrified to an undreamed-of extent as more and more equipment is changed over from manual operation to power drive. Retractable landing gear, wing flaps or "air brakes," engine-ventilating cowl flaps, rudder and aileron compensating tabs, antenna reels, bomb and parachute flare releases, retractable oil coolers, and hydraulic and pneumatic pumps, to mention some of the better-known devices, are being electrically driven. The prime requisites of motors for aircraft are light weight and high starting torque. Again, the high speed characteristic, and hence light weight per horsepower, of the series motor wound for 12 or 24 volts direct current, makes it ideal for airplanes deriving their electrical power from storage batteries.

Large transports and bombers undoubtedly will be equipped eventually with special high-frequency generators enabling them to employ high-cycle induction motors, but on all small planes and some of the larger ones the power supply is either 12 or 24-volt current from storage batteries.

Variable speed transmissions are becoming important factors in industrial power transmission and speed control. Many units of different designs are now on the market, but they all use a handwheel of some sort for manual variation of speed. Often, however, it is desirable to control the transmission from distant points, in which case a pilot motor connected to the handwheel shaft and subject to pushbutton or automatic control is used. This motor must have rapid acceleration (high starting torque) to provide prompt response to speed-change demands and must be capable of instant reversal. A series motor equipped with a built-in speed reducer is shown in *Fig.* 3 for controlling a Reeves variable speed transmission.

Powers High Speed Tools

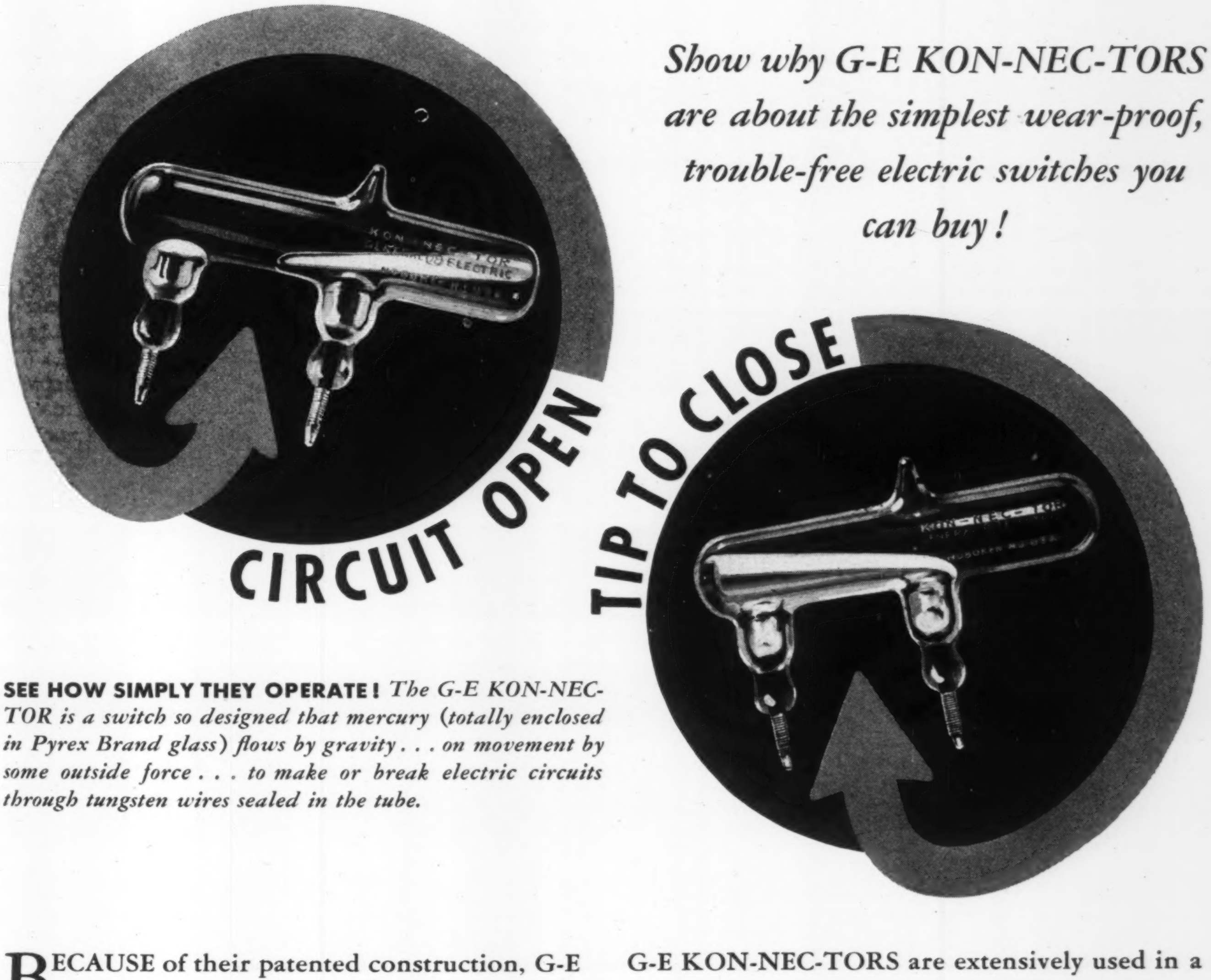
Routers, used by printers in finishing electrotypes, by woodworkers for mortising and for slotting venetian blind slats, and by other industries in working wood, metal and plastics, require high speeds from 12,000 to 20,000 revolutions per minute in order to cut properly. The motor used should be light because it is usually mounted on the router frame which must be moved over the working surface by the operator. In *Fig.* 4, a series motor powers a Challenge portable router.

A great many small flexible shaft tools are used by dentists, jewelers and die makers. Because much of the work is fine and requires small bits, the speed must be fairly high. At the same time it must be possible to vary the speed over a wide range owing to the different characteristics of various materials to be worked and the necessity of occasionally using larger bits. The motor is generally hung from a bracket overhead for the convenience of the operator and hence should be light. The series motor, with its high and variable speed characteristics and its light weight, is a practical power unit for such tools.

Where constant speed, together with light weight

PICTURES TELL THE STORY!

Show why G-E KON-NEC-TORS are about the simplest wear-proof, trouble-free electric switches you can buy!



SEE HOW SIMPLY THEY OPERATE! *The G-E KON-NEC-TOR is a switch so designed that mercury (totally enclosed in Pyrex Brand glass) flows by gravity . . . on movement by some outside force . . . to make or break electric circuits through tungsten wires sealed in the tube.*

BECAUSE of their patented construction, G-E KON-NEC-TORS may be operated millions of times with unvarying efficiency. They are adaptable to the design of all kinds of electrical machinery . . . and may be depended on to provide clean, positive make-and-break of the electrical circuits involved.

G-E KON-NEC-TORS are extensively used in a wide variety of installations including: elevators, ice cream cabinets, temperature recording instruments, steam and oil boiler systems, electric ranges, storage water heaters, printing presses, and many more. For further specific information write to the address given below.

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GENERAL ELECTRIC

410 Eighth St., Hoboken, N. J.

THIS CAN BE FILED FOR REFERENCE!

These pages represent the fourth edition of the "Machine Drives and Controls" Supplement. Presented as an integral part of the April 1940, issue of MACHINE DESIGN, it is written and compiled for design executives in the machinery manufacturing field, for the express purpose of bringing together factual information that will aid them in their daily problems.

To serve readers most effectively the Supplement has been stitched separately as a composite unit, and then stapled into the center of the magazine so that it can be taken out by removing two staples without injury to the insert or to the magazine proper. This permits filing by subject to provide ready reference.

With the editorial contents written and edited to assist designers of machinery in selecting the best possible drives or controls for their conditions, the Supplement will find immediate acceptance and use. The advertising section constitutes a veritable "Where-To-Buy" Directory.

Like MACHINE DESIGN'S previously-published Directories of Materials and Special Supplements covering specific phases of design, this special section adds another valuable reference work to the engineer's library.

MACHINE DESIGN

**The Professional Journal of
Chief Engineers and Designers**

***Covers every size and type of machinery---
from the "Wristwatch to the Locomotive"***

and high starting torque, are required electric governor control is used. The electric governor is a centrifugal device mounted on the armature shaft which, by rapidly making and breaking the motor circuit, limits the speed to a predetermined value. The range of speeds a governor will handle is approximately from 2000 to 8000 revolutions per minute. Setting for a certain speed is accomplished by adjustment of a set screw controlling the vibrating points, and this may be done either while the motor is at rest or in operation, depending upon whether a fixed or adjustable type governor is used. The adjustable governor is a convenient means of accurate speed variation, holding the speed constant wherever set.

Many Applications for Speed Control

A typical machine employing electric governor-controlled series motors is the oxyacetylene shape cutter. A template of the shape desired is made of aluminum strip, over which is mounted a motor-operated carriage carrying the oxyacetylene torch. Extending from the carriage are a pair of knurled guide wheels which run on each side of the aluminum strip, thus causing the flame to trace a path on the steel identical to that of the template. The motor operating the carriage must operate at constant speed wherever set in order to obtain a smooth and uniform width of cut, and yet it must be capable of speed variations over a wide range to accommodate metals of different thicknesses. As the motor is always started under load, starting torque must be good.

Governor-controlled series motors are also applied to portable sound movie projectors. The speed must be held absolutely constant to insure good sound reproduction. A synchronous motor would provide constant speed but it would be large and heavy for a portable machine.

A popular kitchen mixer employs a governor-controlled series motor for three reasons: Light weight, small size and wide speed variations without reduction in torque. A rheostat would provide speed variation but would also substantially reduce the torque, which would be distressing to the housewife when mixing a heavy batter.

Electrically-operated business machines, such as typewriters, adding machines, calculators, tabulating machines and time recorders are being equipped more and more generally with this type of motor, either with or without governors. In the laboratory, series wound motors are used because of their light weight, small size and ease of speed control. Mixers, high-speed fatigue testers, compression, shear and tension testers are examples.

These examples serve to show how this type motor meets important needs in industrial, commercial, scientific and domestic fields. The series motor is only one of several distinct types of fractional horsepower motors, each of which answers a different kind of need. The more fully the advantages and potentialities of each type are understood the better able will those who manufacture motors be to meet requirements satisfactorily and completely.

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Write today for more detailed information or send us your motor problems.

47
YEARS OF
LEADERSHIP

PEERLESS ELECTRIC CO.
WARREN, OHIO

Reduces Starting Torque

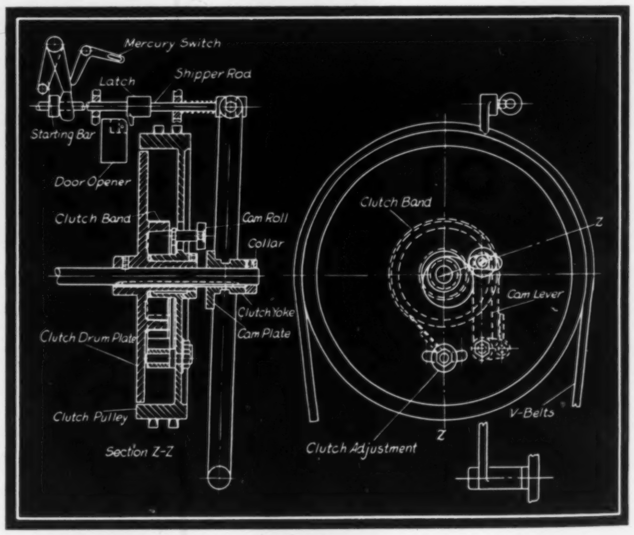
(*Continued from Page* 29-S)

the wear occurring when the clutch is being engaged. A stud is securely locked in a slot located in the side of the clutch pulley to which one end of a thin piece of spring steel is fastened and wrapped around the clutch drum. The other end of the steel band is secured to the short lever of a ball crank or cam lever, pivoted on another stud located in the side of the clutch pulley.

Cam Controls Clutch

If the long arm of the cam lever is pushed outward from the center of the pulley, the band will be tightened about the drum. If enough pressure is used this action will lock the two pieces causing them to revolve as a single unit. In order to obtain this locking action, a stud carrying a cam roll fastened to the long arm of the cam lever extends through the web of the pulley, and is forced outward by an eccentric or cam plate cast integral with the clutch yoke located on the drive shaft. The cam plate revolves with the shaft.

Clutch operates in the following sequence: The pulley is revolving in a counter clockwise direction. The cam lever and clutch band are likewise revolving with the pulley as they are secured to it. Moving the clutch yoke and cam plate into a position directly adjacent to the hub of the clutch plate effects clutch engagement. As the pulley revolves, the cam roll begins to engage with the cam plate. As this cam is eccentric with the center of the shaft, it will gradually force the end of the cam lever outward from the center of the pulley, thus gradually tightening the band on the clutch drum. Since this tightening of the band takes place gradually, there is some slippage between the two until the clutch has picked up the load. Thus a slow acceleration is secured, providing easy starting. A positive drive is guaranteed as the action of the pulley is tending at



all times to force the cam lever farther outward from the center, thus tightening the steel band.

The clutch is locked in the running position by means of an electric door opener and latch. As knitting looms are made in varying widths, it is necessary that the operator have control in starting or stopping at any point in the width of the machine. Therefore, a starting bar is provided. This bar extends the full width of the loom and is pivoted at each side. Pulling on the bar engages the clutch. Pushing on it tilts a small mercury switch which in turn energizes the door opener; thus permitting the spring on the shipper rod to release the clutch. This electrical type of release is used, as a stop motion is also provided to operate if any one of the several hundred ends of yarn breaks or terminates. The stop motions are electrical and operate the door opener when a contact is made in the same manner as the tilting of the mercury switch.

Instant release is obtained by a spring on the shipper rod. The cam roll and cam have slightly tapering faces which insure separation as soon as a force in the opposite direction is applied to the clutch yoke. There is also enough spring in the friction band to give positive release once the pressure is removed.

Flywheel effect is provided by the heavy rim on the clutch pulley. This weight provides enough kinetic energy to smooth out the reciprocating action.

Shell Type Motor Assures Alignment

By Henry K. Spencer

Manager
The Blanchard Machine Co.

WE HAVE had experience with direct motor drive of spindle since 1914 and the early arrangement was to use a round frame motor mounting the stator at the lower end of the wheelhead and leaving the upper end entirely free of any connection with the rest of the wheelhead. The rotor was pressed and keyed on the spindle. This drive had the advantages of simplicity and sturdiness and presented a better appearance than the drives in which the complete motor is coupled or otherwise connected to a spindle.

About five years ago we adopted the shell type motor for the wheelhead of one of our surface grinders. The use of the shell type motors reduces the space occupied by the motor to that which is required for the essential magnetic and electrical parts of the motor and therefore allows greater freedom in the design of the rest of the wheelhead than would be the case if more of the parts of a conventional motor were used. Better appearance is also secured because the drive is entirely enclosed in the wheelhead and the exterior can be made to harmonize with the general design of the machine. There is also some saving in cost since the shell type stator should cost less than a stator mounted in a frame. In small quantities there may be no saving in cost or the shell type may even cost more as it is made to special dimensions in small quantities.

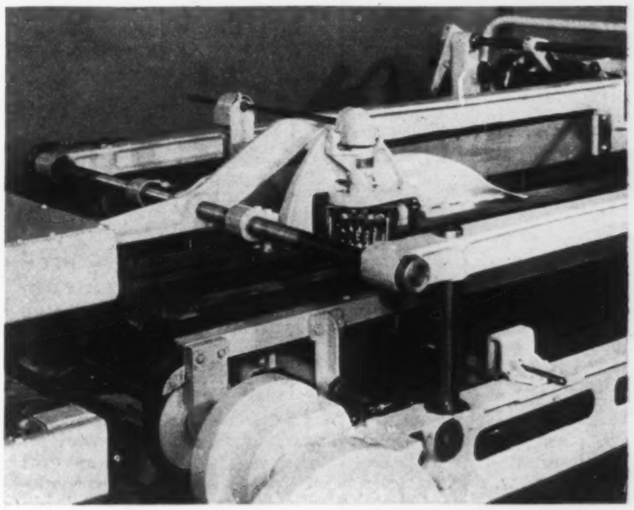
The machining of the wheelhead for mounting the shell type is simple and good alignment is readily secured. If the shell type stator is removed for repairs it can be put back in place with the assurance that alignment will again be perfect. If attention is given in the design to making the stator readily removable it should be just as easy and, in some cases easier, to remove a shell type stator for electrical repairs than to remove a more complete motor which is bolted in place and coupled to the spindle. If the motor is to be replaced by another one, the shell type is advantageous because if the outside diameter fits the bore of the wheelhead there is no question about alignment.

Conveyor Lugs Index Imprinting

By J. L. Ferguson

J. L. Ferguson Co.

IN A NUMBERING device for a case sealer, the driving of a set of type at definite speed with relation to container travel, and operating only when container is in position are required. In the machine illustrated, two horizontally placed sprockets, with suitable connections, drive the type. One is the driver and the other the idler of take-up sprocket, both connected by a chain. The chain has incorporated thereon a multiplicity of carrier or pusher lugs. These lugs contact the leading end of the container. The container to be numbered supplies the motive power for turning the type.



When containers are longer than the pusher lug centers, intermediate lugs collapse by weight of container acting against lug spring. This collapsing feature allows only one set of type impressions to be placed on each container, because type drive is inoperable unless lug is in raised position. In this way drive is automatically indexed with the end of each package.

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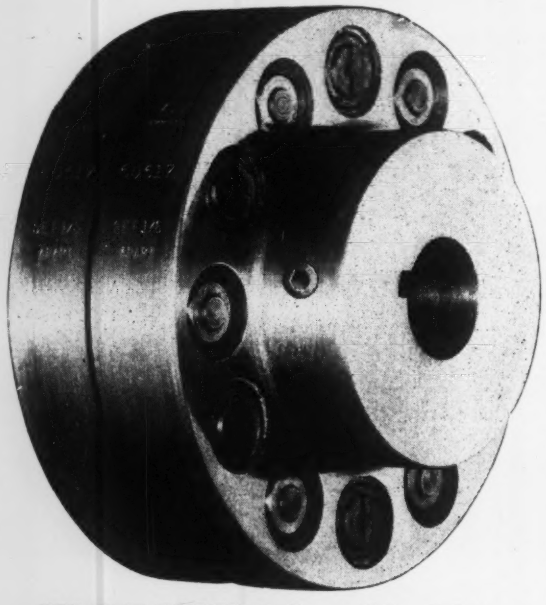

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AJAX FLEXIBLE COUPLING CO.

Incorporated 1920
Westfield, N. Y.

Pick the Right Control!

(*Continued from Page* 37-S)

motors and nonreversing—resistance type starter for direct-current motor.

Overload protection for motors is desirable on practically any type of service. High current peaks that occur when starting the motor, and overload currents that exist for short periods without danger to the motor should be permitted by the overload protective device. It must, however, operate to remove power from the motor when it is endangered by continuous overload conditions.

Match Overload Protection to Service

Since heat is the final cause of damage to a motor when overloads occur, a heat-responsive device located within the motor should be a satisfactory overload protective device. Such a device, known as a thermoguard, contains a contact that opens when the device is sufficiently heated and this contact in turn operates the magnetic controller to disconnect all power.

Because the heat within a motor depends upon the current or load on the motor, most overload protective relays use the current in the lines to the motor as an indication of the thermal conditions within the motor. To permit high motor currents for short periods of time, overload relays having thermal elements are commonly used.

The operating elements of thermal relays require some time to become hot enough to actuate the relay. Therefore, short-time peak currents are permitted without operating the relay and controller to stop the motor. Long-time overload currents that endanger the motor, however, will heat the relay parts to operating temperatures.

Low Voltage Protection Desirable

Voltage failures may occur on a power supply system at any time. All motors connected to the system, of course, stop when the voltage failure occurs. For machine applications where operators are present, an unexpected start must not occur when power returns. Such starts are prevented by selecting the proper type master station and making the proper control connections. The most commonly used master switch for this protection is a pushbutton station of the momentary contact type. With this arrangement the motor will not start after a power failure, even though power is again available, until the operator depresses the start button. This circuit is spoken of descriptively as one giving "low voltage protection."

There are some applications such as fans and pressure pumps where no attendant is present and where operation at any time is essential. For such cases the master switch and circuits are selected so that the motor will start when power returns after a failure has occurred. Typical master switches for this

STUDYING VALVE ACTION

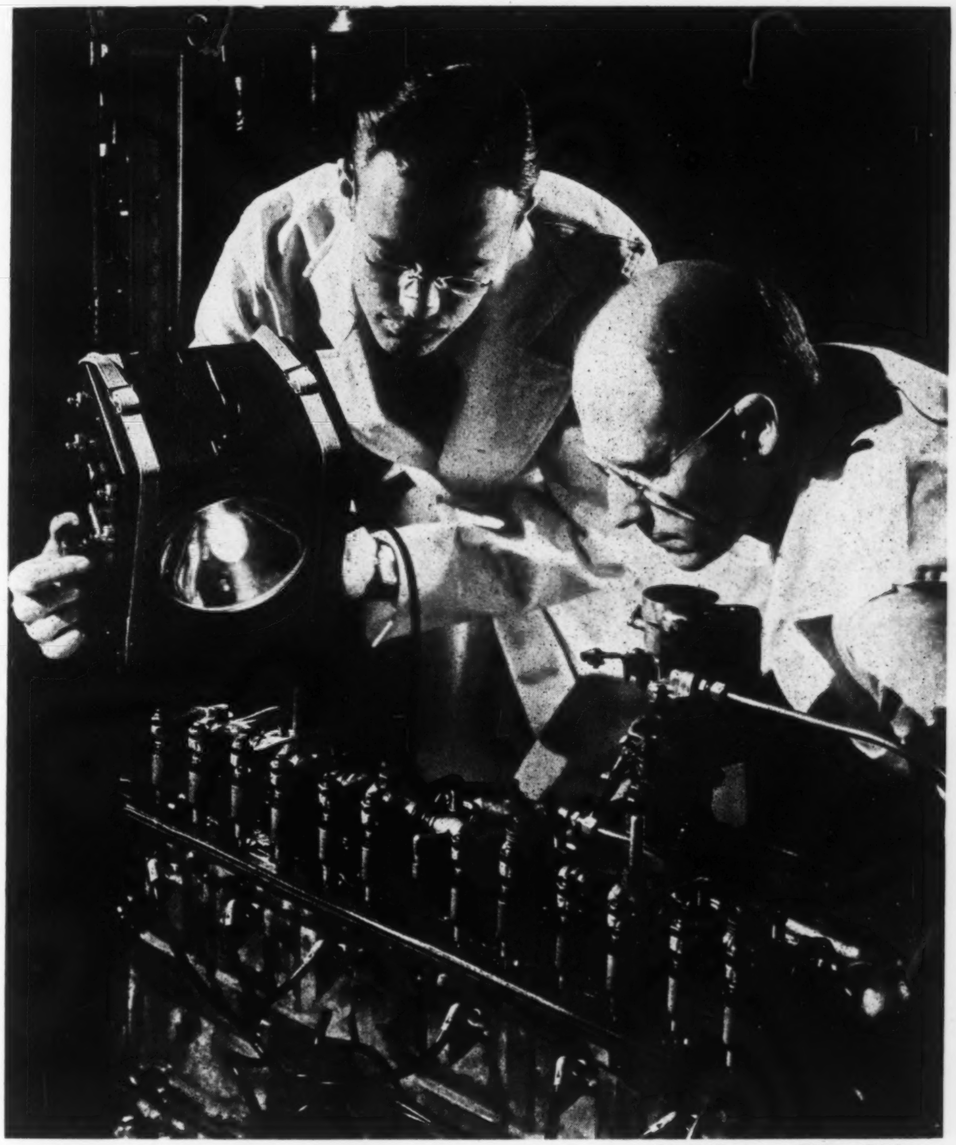

Photo Courtesy Wilcox-Rich

AS HAVE THOUSANDS of other manufacturers, Wilcox-Rich of Detroit find constant use for the STROBOTAC in their laboratories. The engineers above are studying the operation of the valve mechanism in s-l-o-w motion. Floating of the valve gear, which will result in noisy and improper engine performance at high speeds, is easily verified by an irregular valve lift curve as the valve moves in slow motion under the light of the STROBOTAC.

Throughout the entire mechanical industry . . . in design . . . in research . . . in production . . . in maintenance . . . in sales . . . the STROBOTAC has become the accepted method of studying motion even in machines operating at speeds up to 100,000 rpm.

With the STROBOTAC you see in s-l-o-w motion the exact operation of any machine or part. In addition the STROBOTAC is a very accurate direct-reading tachometer requiring no mechanical or electrical connection to the equipment being measured. When so used it is direct-reading in rpm from 600 to 14,400.

The STROBOTAC is inexpensive, too. Complete and ready to use on any 115-volt 60-cycle a-c line it costs only $95.00.

Let us tell you how the STROBOTAC can help you!

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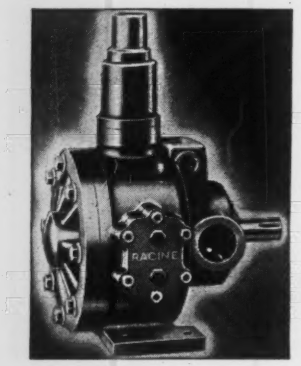

Extremely quiet, smooth performance. A thoroughly proven, efficient pump for pressures up to 1000 lbs. per sq. inch. Capacities 2000—4000—6000 cubic inches per minute.

The Variable Volume feature saves horse-power. Delivers amount of oil actually required. Volume is controlled automatically or manually.

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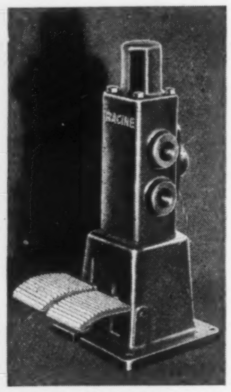

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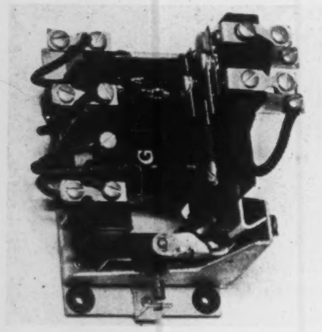

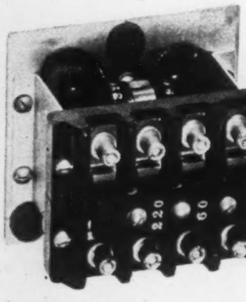

LOW VOLTAGE—HIGH CAPACITY ELECTRIC CONTROLS

Above is illustrated a B/W Induction Relay for low voltage on control switches. Relay contacts carry higher voltages up to 550 volts and loads up to 1 h.p. Made in a variety of forms, and voltages and cycles of A.C. only.

Above is a 10 h.p. 220 volt 4-pole contactor which measures only 4″ wide, 3¾″ high and 3½″ deep. Many unusual features of design, and long life. For A.C. only, can be furnished with thermal overloads or in reversing type.

SEND FOR FREE BULLETIN DESCRIBING THESE AND OTHER CONTROLS

BENDER WARRICK CORPORATION
121 Pierce Street
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Pioneers of All-Electric Floatless Control, Manufacturers of Motor Starters, Thermal Overload Units and Relays.

service are float switches, pressure switches, and pushbuttons with maintained type contacts. This combination of master switch and circuit is identified as one providing "low voltage release."

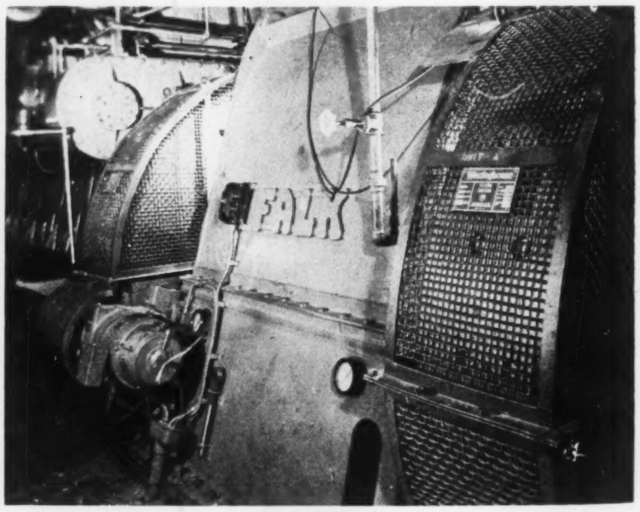
Choose Right Enclosure

Four general types of enclosures are utilized for housing control units. The simplest is a protective covering of sheet steel to prevent accidental contact with any live parts. Such an enclosure would also provide protection against chips. Drip-proof enclosures are not tight designs and may be ventilated. Precautions are taken to prevent falling moisture from entering through any opening of fitting. Dust-tight and water-tight enclosures have gasketed doors and the entire construction is such that no dust or water can enter. No ventilation is provided.

Where acid fumes are present, it is difficult to protect electrical apparatus against corrosion. One method is to use a suitable tank and immerse the entire control panel in oil. If a supply of fresh air is available, it is possible to use the simplest type of enclosure and pipe a supply of fresh air to maintain a slight pressure within the enclosure so that the acid fumes cannot enter.

Type and design of enclosure is influenced, to a great extent, by the design of the controller. Resistors used to start and stop motors generate heat. If the motor starts and stops frequently the heat generated by the resistors must be considered and a ventilated cabinet may be required. If ventilation is impossible it may be advisable to place resistors in a separate enclosure.

Excessive temperatures damage the insulation on wire and on operating coils of contactors and relays. High ambient temperatures also increase the operating temperatures of the current-carrying parts and decrease their ability to handle normal motor loads. Enclosed apparatus is generally derated to 90 per cent of its normal or open rating for this reason.



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BRIDGES THE GAP BETWEEN MOTOR DESIGN AND MOTOR PERFORMANCE

The potential performance of a motor is implicit in its design; but *actual* performance—the ability of a motor to meet your requirements—is determined by the manufacturing methods of the motor builder.

Delco Products has received full benefit of the research and engineering facilities of General Motors Corporation in "streamlining" its plant operations to match the excellence of Delco motor design. Specially-built machines, developed by Delco Products engineers and General Motors Research, control tolerances and assure accurate relationship between all machined parts. Every group operation contributes to the lasting satisfaction of Delco motors, from the first turning operation to the dynamic balancing that reduces vibration to a minimum.

The qualifications of Delco motors to meet your industrial needs are based on manufacturing excellence. For further information, consult the Delco Products Engineering Department.

Delco Products industrial A.C. motors are available in various types, possessing electrical and mechanical characteristics to meet practically every requirement. Each type available in open-frame, sleeve or ball bearing—totally enclosed ball bearing—totally enclosed fan-cooled ball bearing—also multi-speed motors. Electrical and mechanical modifications available.

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Low Cost
VARIABLE SPEED
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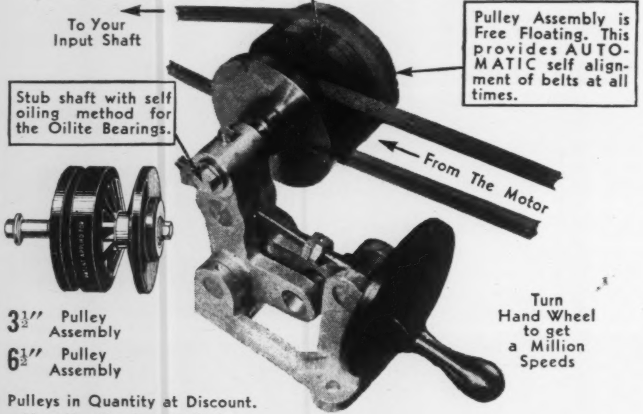
This center block moves sideways when the hand wheel is turned. Thus one side gets large while the other side gets small.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Not Just 3 to 1 . . . . BUT OVER 6-to-1 RATIO
No Special Belts . . . . JUST STANDARD "V" BELTS
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1321 Washington Ave. S. Minneapolis, Minnesota

Built-in V-Belt Drives Save Space

(*Continued from Page* 39-S)

load-transmitting capacity, provided the many factors concerned can be equalized, is attained at 4200 feet per minute. Theoretically, the higher the belt speed, the greater power it can transmit. But centrifugal force sets up an extra tension, part of which in turn is used to counteract centrifugal effects and hence does not aid in transmitting power.

Because V-belts stretch very little after being "broken-in," a small amount of change in belt length in a short center drive will have a marked effect on belt tensions and the ability to carry the full rated load. Yet during the initial stages of operation the fibers become matted down and the belts sink deeper into pulley grooves, so that ample take-up must be provided for in the design in one way or another. This can be accomplished by the use of slide rails under the motor, by an idler on the under side of the belt, by an adjustable motor base, or by other means. At least 2½ per cent of the center distance must be taken up, and if space is available up to 10 per cent.

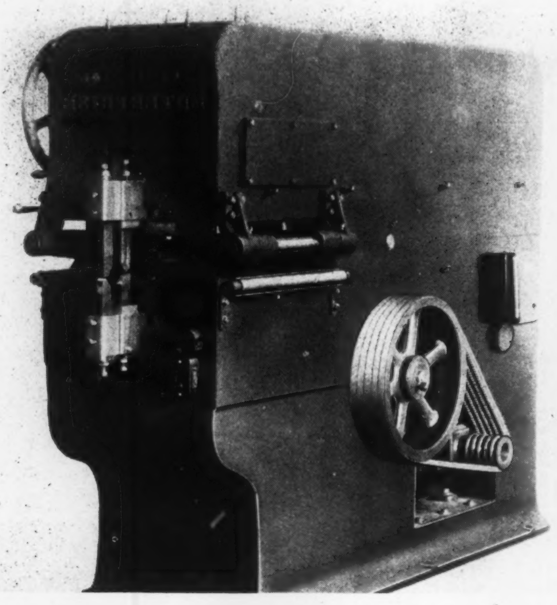

Fig. 6—This special machine tool shows a high ratio drive. Shield has been removed

The opposite factor, provision for slacking off, must also be considered in the design. That is, it should be possible to move two sheaves closer together than they would be in their actual running position. Amount of this slack-off should be such that a belt can be placed in the sheave groove without being forced with a tool.

Under proper tension, V-belts will not slip to a damaging extent, but insufficient tension causes slackness and hence slippage and undue cover wear.

Fig. 4, showing a battery of V-belts in operation on spinning frames in a textile mill, illustrates an application where the constant speed, cleanliness and quiet-

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that help you to—
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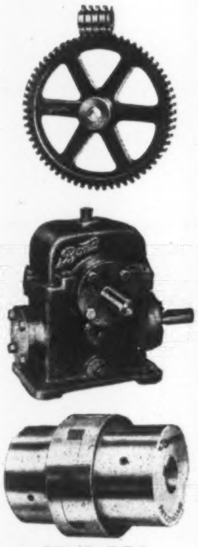

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Many types of Worm Gear units for reduction drives from 1/30 to 6 H.P. Ratios up to 4,000 to 1. Quality construction throughout. Also special units made to your specifications.

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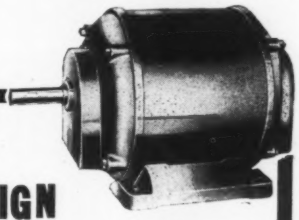

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(Ball-Bearing Motors ¼ H. P. to 40 H. P.)

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Acknowledgment

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Machine Design takes this opportunity of thanking all those companies and individuals who contributed toward the preparation of the accompanying "Machine Drives and Controls" Supplement, stitched into the center of this April issue. We are particularly indebted to the manufacturers of machinery and to the producers of drives and control equipment for their cooperation and support in making this Supplement possible.

★

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IDEAL "SELECT-O-SPEED" Transmission

Low cost variable speed transmission. Gives your machines a new, powerful selling argument.

Trying to sell some fixed speed equipment now-a-days is just like trying to convince John Q Motorist that he should buy a car with two-wheel brakes. That's why so many original equipment manufacturers equip their motorized products with "Select-O-Speed" variable speed transmission. It gives them an opportunity to boost sales by offering their customers an infinite selection of machine speeds to meet their every requirement—priced so low that they can't afford to turn it down.

Capitalize On These Plus Features

1. Low cost permits use even on your least expensive equipment.
2. Infinite range of speeds over a 5-to-1 ratio (higher ratios available).
3. Uses standard "V" Belts.
4. Simple to install.
5. Sizes from Fractional to 7½ H.P.

Have our Trained Engineers give *you* recommendations for *your* specific equipment

Transmission Division

IDEAL COMMUTATOR DRESSER COMPANY
1059 Park Avenue Sycamore, Illinois
In Canada—IRVING SMITH, Ltd., Montreal

TIME CARD

HOW MANY PRODUCTION HOURS IN AN Abart SPEED REDUCER?

We frankly can't tell about the hours—but we can point with pride to actual records that show Abart Reducers in day-in and day-out, month after month, year after year service—with practically no maintenance expense at all. Figure what that means in terms of power transmission profits. These Abart Reducers paid for themselves years ago, and now every minute of additional service adds to profits alone. Write for complete catalog.

GEARS—Fine craftsmanship — good materials — no stocks — made to your B/P or specifications. Let us quote.

1½ A and SA Unit Horizontal Worm Gear Drive

Abart GEAR AND MACHINE CO.
MANUFACTURERS OF
Speed Reducers & Gears
4821 WEST 16th ST CHICAGO, ILLINOIS

ness of V-belts makes them particularly useful. Floor and ceiling space is also increased and more light is admitted. Where it is desirable to adjust the speed ratio without resort to an intermediate mechanical means, sheaves with variable pitch diameters like those in *Fig.* 5 may be used. Effectiveness and versatility of the grinder shown is increased through this method of changing speed ratios. *Figs.* 6 and 7 show two more applications of V-belt drives, on a special machine tool and on a shear knife grinder.

When large speed ratios and very short center distances exist, a large flat pulley can be used with a grooved small pulley, in the type of drive known as the V-Flat. Substantial economy may be realized from the lower cost of the flat pulley and the usual advantages of the full V-belt drive, using approximately the same number of belts, are retained. Maximum pulling power on belts is obtained when the arc of contact on the large pulley is approximately 240 or 250 degrees. The speed ratio should be at least 3 to 1, the center distance equal to or slightly less than the diameter of the large flat pulley. To prevent slippage on the large pulley, more belts should be used if longer centers exist.

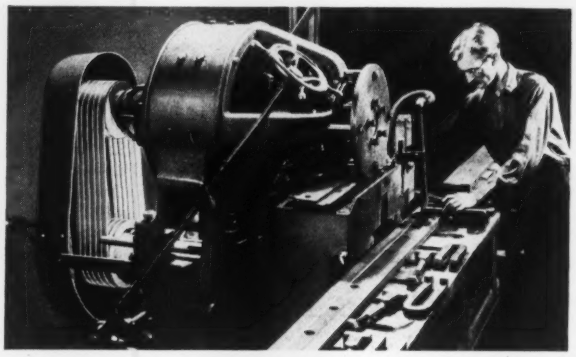

Fig. 7—More accurate grinding and reduced vibration resulted from use of V-belts on this shear

For transmitting power between shafts which are neither parallel nor in the same plane, quarter turn V-belt drives are often used. Certain special precautions must be kept in mind. Speed ratios should not exceed 2½ to 1; center distances should be at least six times the sum of the diameters of the two pulleys and even greater if there are a large number of belts.

From this discussion it is apparent that the modern V-belt drive is virtually trouble-free if selected and applied properly—and the complete literature available makes it a comparatively easy drive to design for average load conditions where starting torque is not excessive and frequent peak loads are not encountered. Overloads and other difficult operating conditions present more unusual problems and demand engineering consultation.

Acknowledgment is extended to the following companies for their co-operation in preparation of information and illustrations in this article: Allis-Chalmers Mfg. Co. (*Figs.* 1, 2, 3 and 5); The Dayton Rubber Mfg. Co. (*Figs.* 6 and 7); Dodge Mfg. Corp.; The B. F. Goodrich Co.; Goodyear Tire & Rubber Co.; The Manhattan Rubber Mfg. division, Raybestos-Manhattan Inc. (*Fig.* 4); Power Transmission Council Inc.

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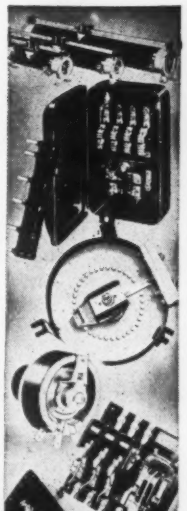

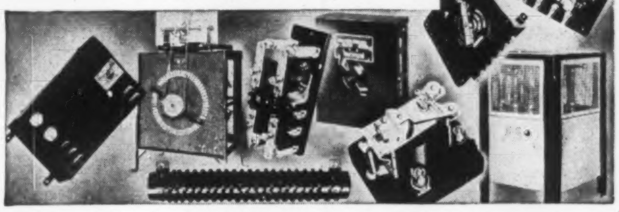

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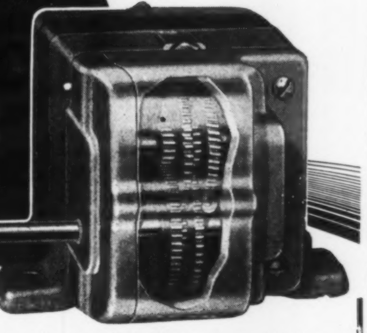
SpeedWay

Worm Drive
Back Geared
FLEA POWER MOTORS
110 VOLT
AC, DC,
or Universal



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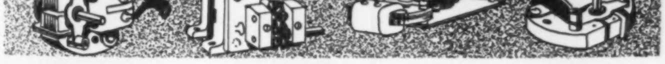
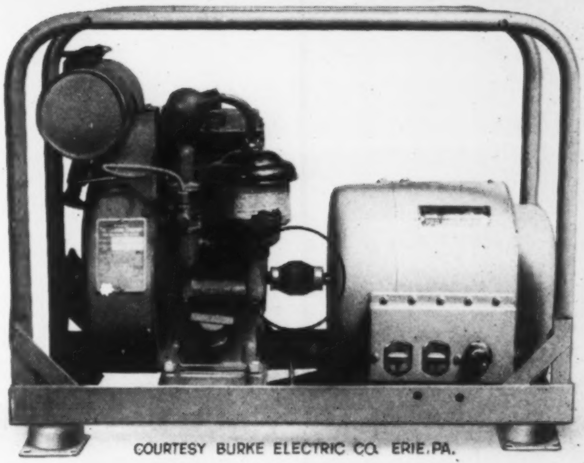


VIBRATION ISOLATION

Clinched the sale of this product...



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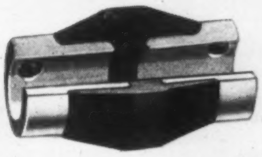
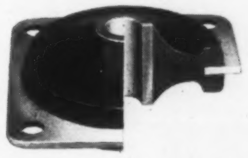
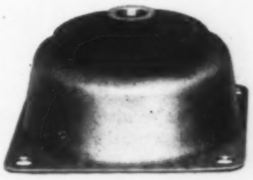


Lord Bonded Rubber Coupling isolated torsional vibration from the driving shaft (¼ section).



Lord Shear Type Mountings isolated the generator from frame vibration (¼ section).



Lord Holder Type Mounts stopped the portable unit from creeping.

By isolating the generator thru a Lord Bonded Rubber Coupling and Lord Shear Type Mountings (not visible on above photo) the manufacturer of this portable engine-generator set met a low voltage ripple specification . . . and by supporting the entire unit on other Lord Mounts they stopped creeping caused by engine vibration.

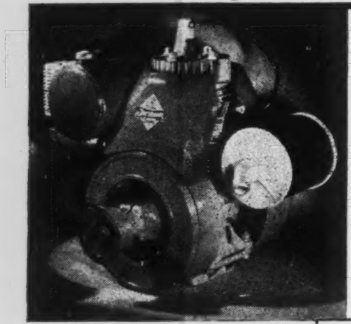
Lord's wide experience in aviation and industrial vibration isolation is yours for the asking.

LORD MFG. CO.
1653 West 12th Street
ERIE, PA.

BONDED RUBBER JOINTS — LORD BONDED RUBBER — SHEAR TYPE RUBBER MOUNTINGS

NEW YORK CHICAGO BURBANK, CALIF.

JACOBSEN
Two-Cycle **ENGINE**



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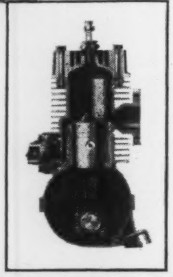
LET US HELP ENGINEER YOUR PRODUCT

We will gladly furnish you with complete specifications, power curve, dimensional specifications and other details which will show you how the Jacobsen Engine fits your power needs.

We are equipped to build a test unit of your product, and if desired, manufacture the product in quantities on a contractual basis.



JACOBSEN MANUFACTURING COMPANY
782 Washington Avenue • Racine, Wisconsin

MACHINE DRIVES AND CONTROLS SUPPLEMENT

APRIL 1940

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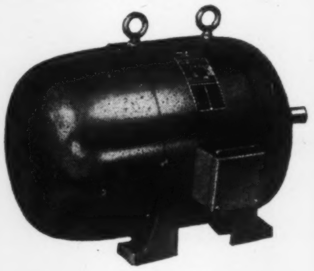
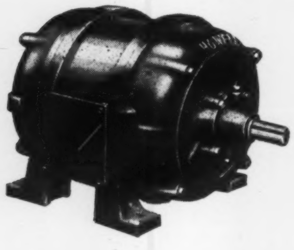
HOWELL
Gets There Quick with
PRECISION-BUILT
SPECIAL MOTORS

TOTALLY ENCLOSED *and* FAN-COOLED

TYPE K (at right) — widely used wherever dust, moisture or fumes make necessary frequent rewinds on open motors. Built ½ to 100 H.P. in any desired design — vertically mounted, etc. Note STREAMLINING which adds attractive appearance to internal quality.





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TYPE SC (at left)—furnished in sizes ½ to 150 H.P.—can be adapted electrically and mechanically to almost any drive purpose — furnished with special end plates, special bases, etc. HOWELL Motors are also built in all multi-speed combinations.

FAST DELIVERY ON ANY DESIRED QUANTITY

IMMEDIATE ENGINEERING SERVICE

The quality of HOWELL Motors is universally accepted by industry. Added to this ability to produce a quality product, is our *unexcelled service* on special motors built to your specific and individual requirements.

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Extremely Adaptable—Reliable—Economical

This Q. A. W. valve can be operated as a 6-way, a double 3-way, or as a 4-way compound exhaust valve. The Q. A. W. line includes a type and a size for every requirement. Q. A. W. engineers are glad to assist with your pressure control problems.

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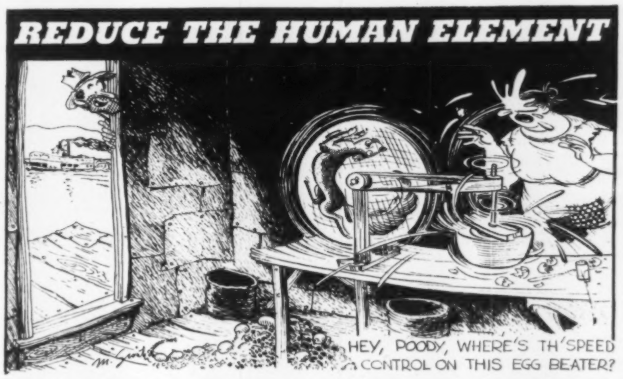
1917 EAST STATE STREET, SALEM, OHIO

6-W

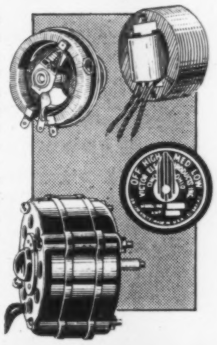
QUICK-AS-WINK
CONTROL VALVES

THE HIGHER THE PRESSURE THE TIGHTER THE SEAL
AIR
WATER
OIL

REDUCE THE HUMAN ELEMENT


HEY, POODY, WHERE'S TH' SPEED CONTROL ON THIS EGG BEATER?

WITH VICTOR MOTORS!



Even in the home, this is the age of speed, be it a hacienda or a houseboat. But if speed is important, speed control is more important. Victor Motors have speed control a-plenty available to you. By means of choke coils Victor Motors give you low, medium, and hi-speeds at the RPM you want; and with rheostats, infinite control . . . without danger of overheating or damage to the motor regardless of RPM. Then, too, you can have gear boxes to reduce speed. In fact, just tell us your wants on fractional HP motors *(1/200 up to 1/10 HP) of the shaded-pole induction type,* and we'll put our motor-medicos to work relieving your motor headaches. They're good, these Victor engineers. One trial will convince you. For information and pictorial bulletin, write

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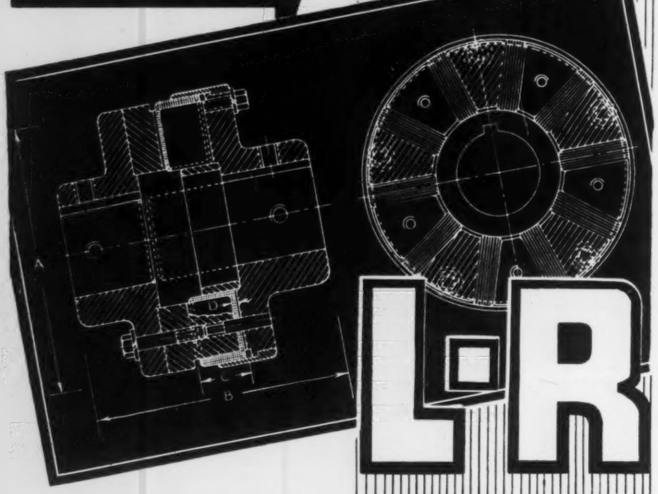
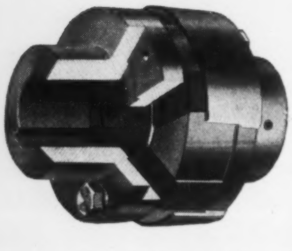


L-R
TYPE HQ
FLEXIBLE COUPLINGS



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April 1940

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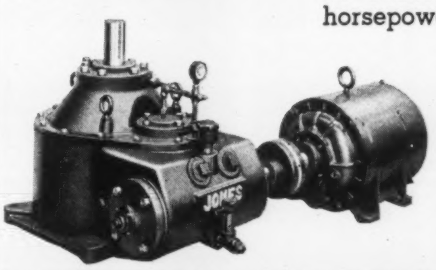
- This Jones Worm-Helical Speed Reducer on a lacquer agitator is typical of the wide range of services for which these drives can be used such as ore roasters, pulp tank mixers, furnaces, bending rolls and similar applications.



The new Jones Bulletin No. 75 covers complete details on these new Worm-Helical Speed Reducers, with rating tables, dimension diagrams, torque charts and other application information. We shall be pleased to send you a copy.

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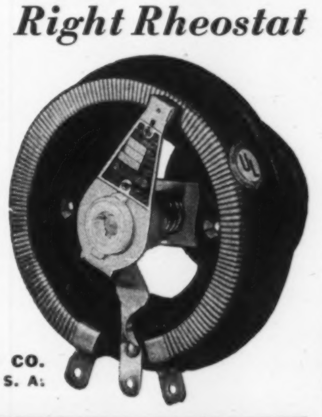

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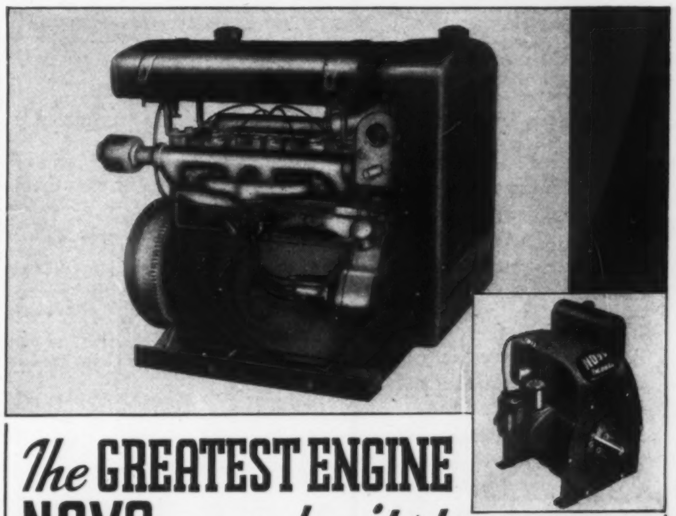

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In addition to control, Hele-Shaw Fluid Power (oil under pressure for driving machines) has other advantages—mechanical simplicity, dependability and ease of operation.

You can locate a Hele-Shaw pump anywhere on or off the machine you drive, near it or remote from it. There is no lubrication problem because the Fluid Power system is self-lubricating.

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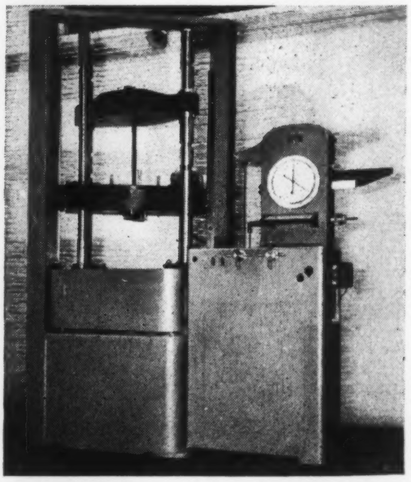
Look into Hele-Shaw Fluid Power before you design, build or buy machinery. If we do not now have the answers to your questions, we'll gladly put our engineers to work on them.



TINIUS OLSEN TESTING MACHINE CO. drive their 300,000 lb. Hydraulic Universal Testing Machine with a Hele-Shaw Pump. Choose it for convenient and accurate control of speed, and power free from pulsations.

A-E-CO HELE-SHAW
***Fluid* POWER**

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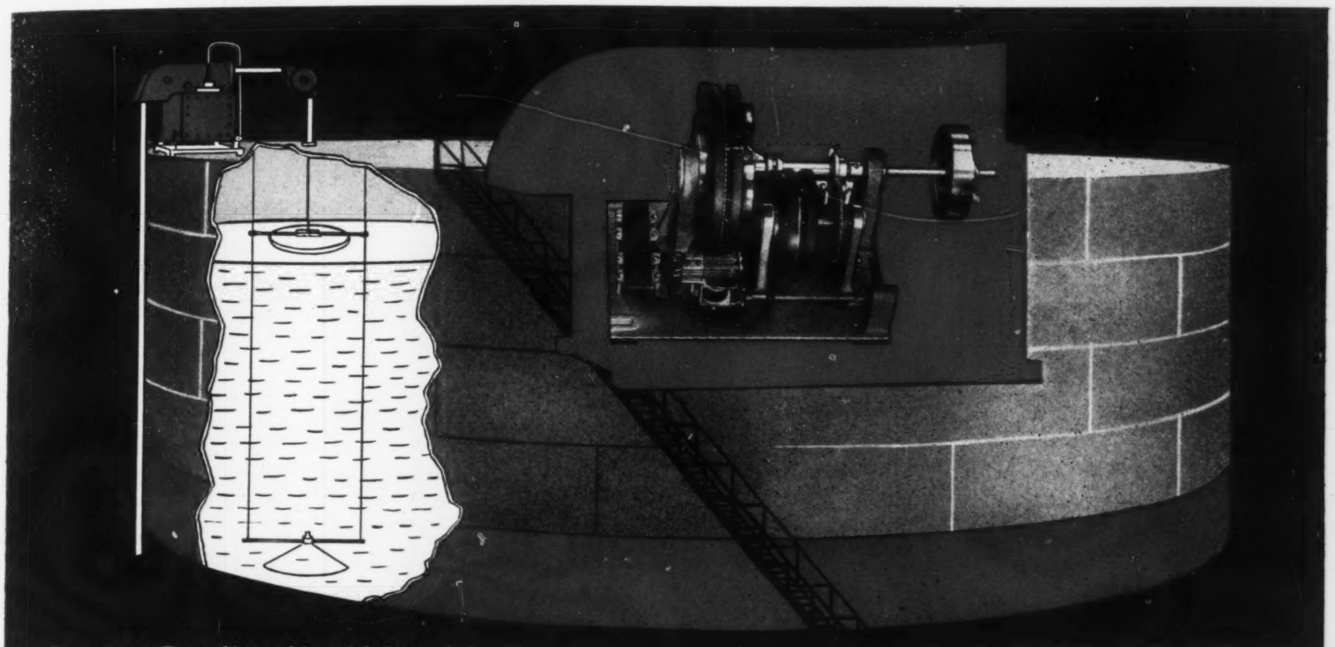

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An Example of *Synchronized* CONTROL

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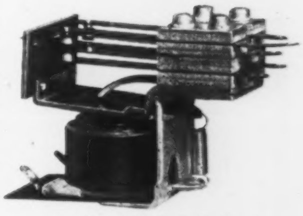
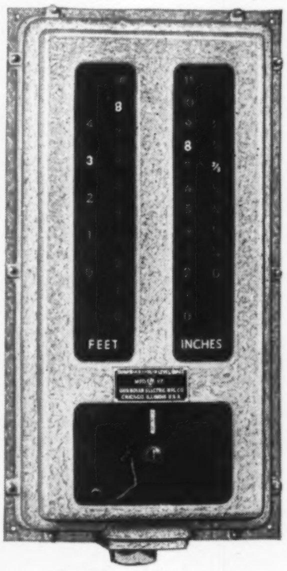


Series 110 AC Relay



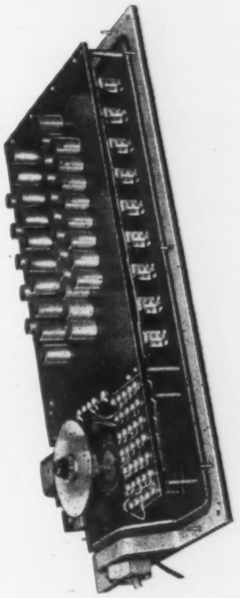
Indicator Panel

RELAYS BY GUARDIAN

Without complete *synchronization* of each relay and control unit to one another—without a perfectly *synchronous* relationship between each mechanical unit—correct readings of dozens of individual tank levels would be impossible. Tested and proved under actual operating conditions, the performance of this new Guardian Gauge verifies the value of Relays by Guardian—of *synchronized* control.

Control mechanism at right consists of banks of Relays by Guardian with a single dialing switch, which, in turn selects any one of dozens of tank head control units at varying distances—a few feet, a mile or miles away.

This specialized application, one among hundreds, serves to illustrate the ability of Guardian engineers. Clearly shows how Guardian equipment—Relays—Stepping Switches—Solenoids by Guardian are designed and built into complete control assemblies to meet specific requirements—should convince you—Relays by Guardian will make your product more responsive, more salable.



Indicator Panel Control

Ask Guardian To Make Specific Recommendations. Write

GUARDIAN ELECTRIC

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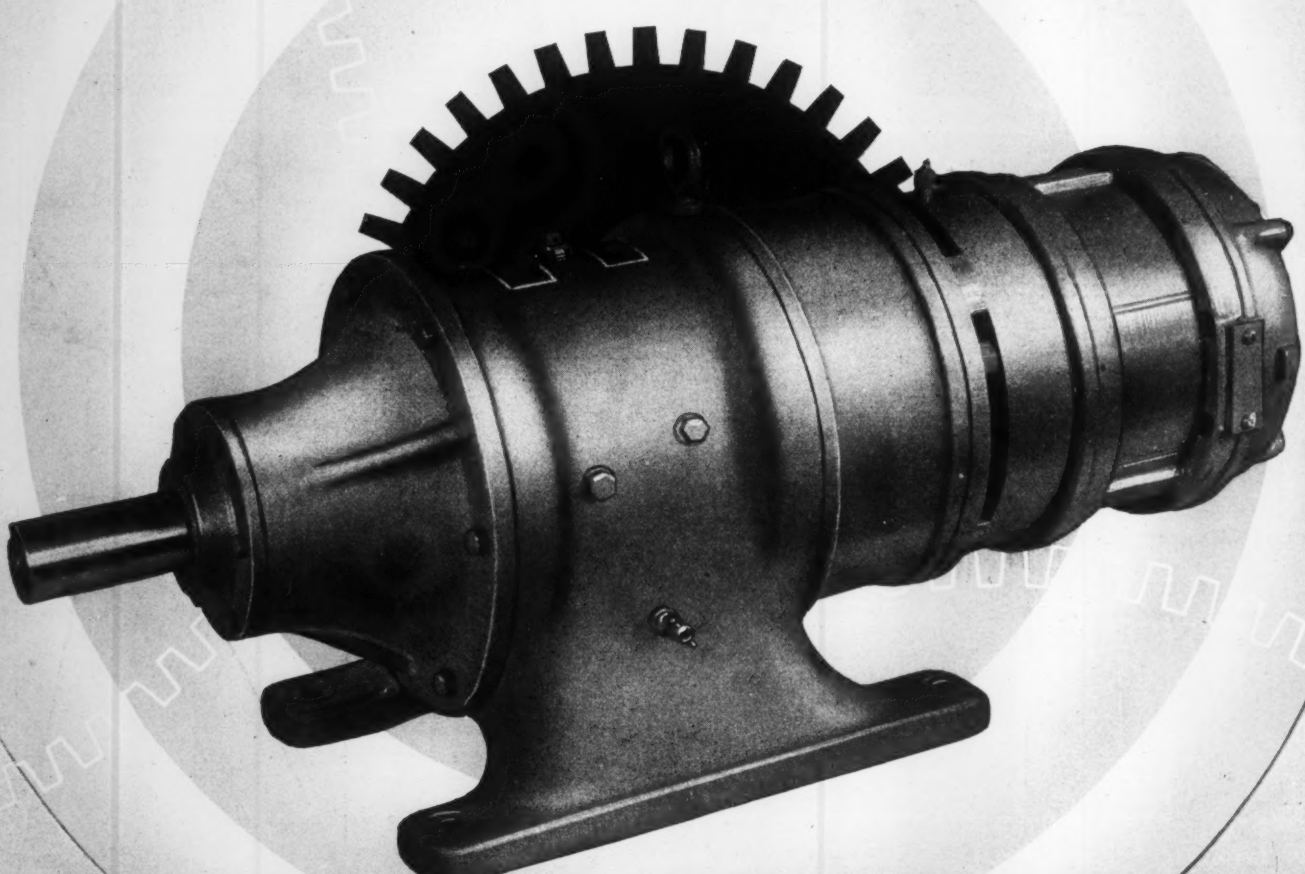
MOTORIZED SPEED REDUCERS



CATALOG No. 17

Containing engineering data, weights and prices on a most complete line of Motorized Speed Reducers is now ready for distribution. We will gladly send you a copy. May we?

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MANUFACTURING CO.
1120 W. Monroe Street
Chicago, Illinois

D. O. JAMES

FOR OVER FIFTY YEARS MAKERS OF EVERY TYPE OF GEAR AND GEAR REDUCER

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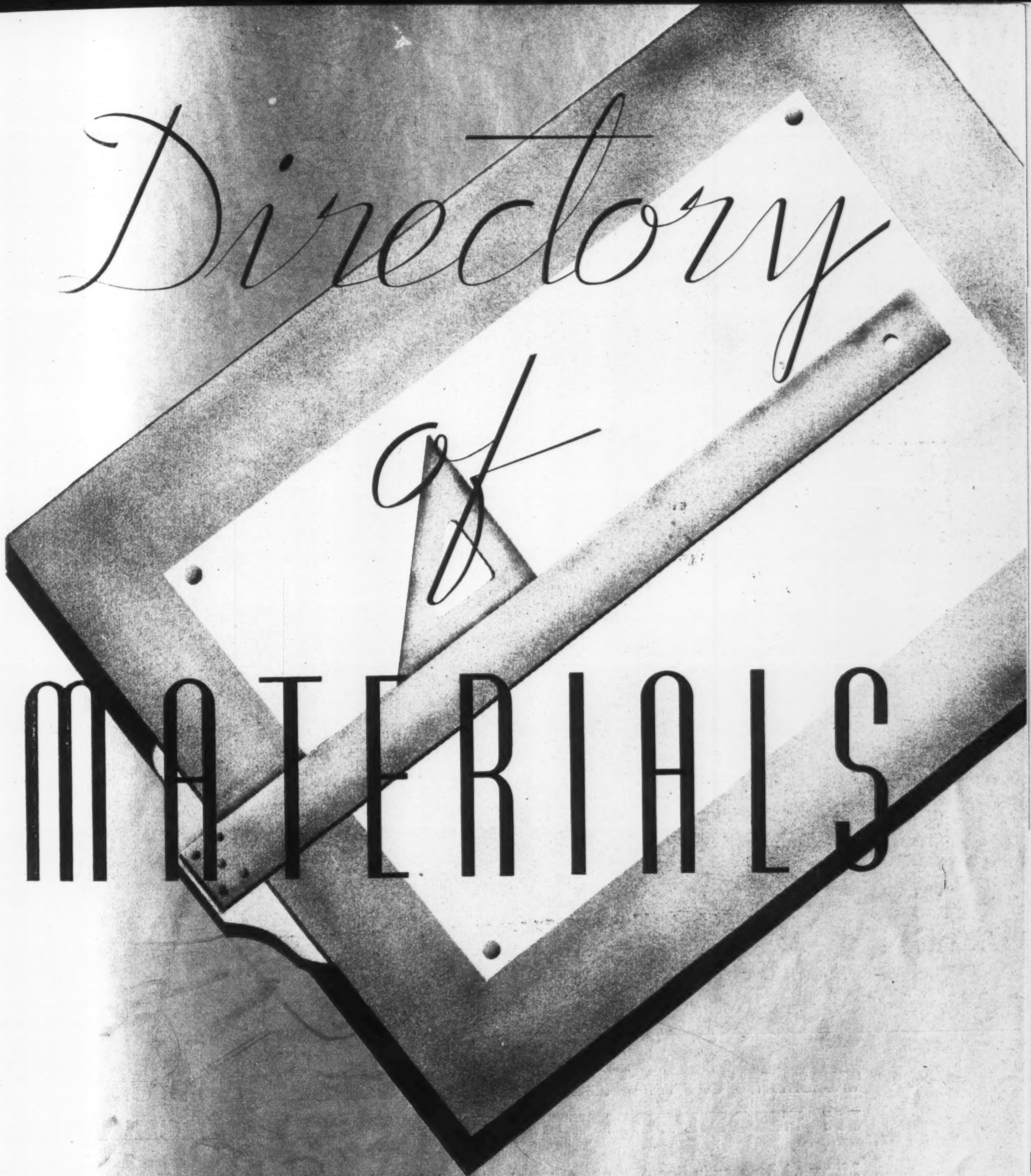
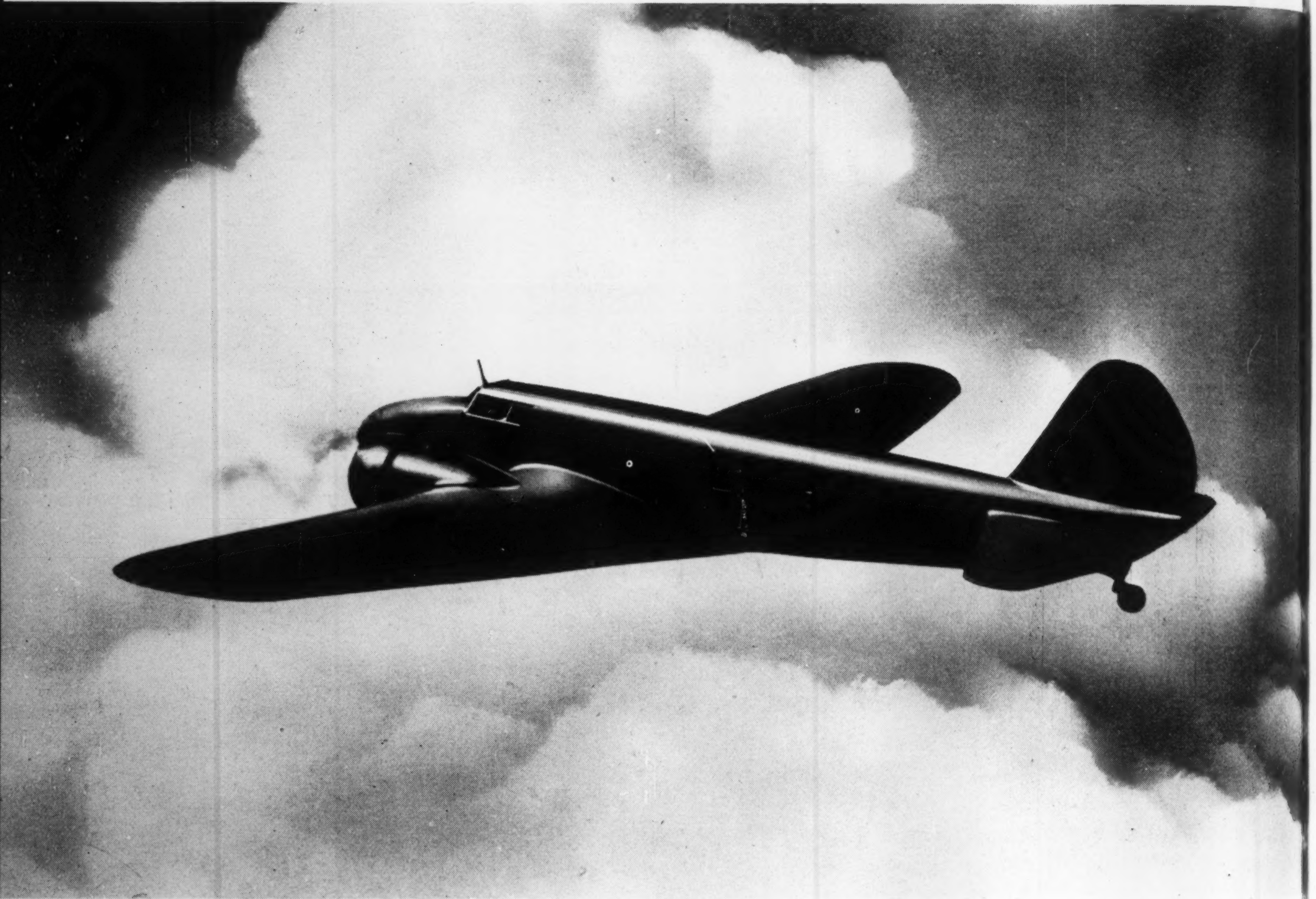
of
MATERIALS



EIGHTH EDITION

SUPPLEMENT TO MACHINE DESIGN'S OCTOBER, 1940 ISSUE

When you're up 37,000 feet the fuel pumps have to work!



THAT'S WHY "SABECO" BRONZE IS USED IN THOMPSON FUEL PUMPS FOR AIRCRAFT

Many of America's finest transport and war planes being flown today use fuel pumps manufactured by Thompson Products, Inc., and after many months of testing, Thompson Products found that "SABECO" Bronze was by far the most consistently efficient, long wearing material for bearings and seals • In scores of products — refrigerators, motors, water pumps, machine tools — and any other piece of machinery which requires bronze parts, "SABECO" is the ideal metal • Write today for further facts about "SABECO."

"SABECO

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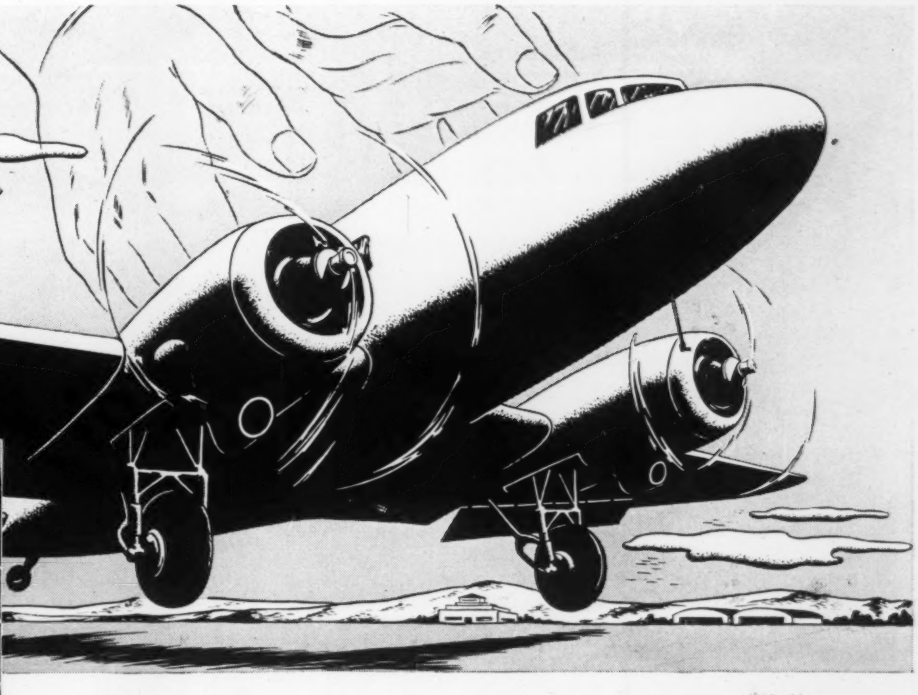
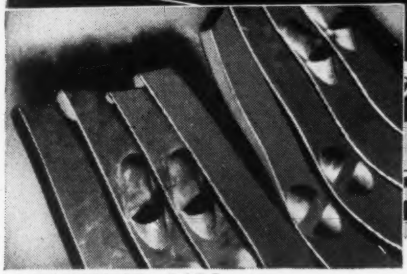
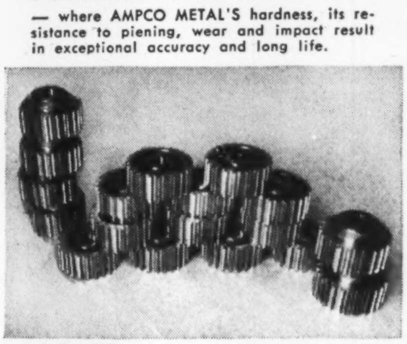
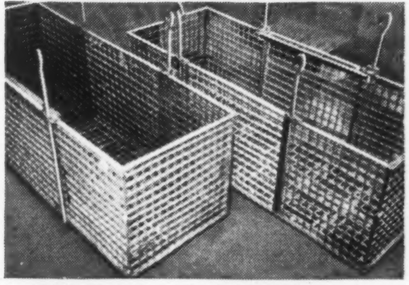




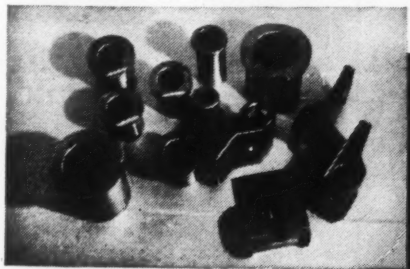
FORMING DIES . . .
— where AMPCO METAL'S hardness, its resistance to piening, wear and impact result in exceptional accuracy and long life.



GEARS . . .
The toughness and wear resistance typical of AMPCO METAL recommends it for all types of gears, ranging from a fraction of a pound to hundreds of pounds each.



PICKLING EQUIPMENT . . .
AMPCO METAL'S great resistance to corrosion makes it widely used in this type of service, and wherever else corrosion is a problem.



BEARINGS . . .
AMPCO METAL is probably more widely used for bearing service than any other bronze. It is noted for its stubborn resistance to wear, "squashing out" and shock loads.

Like *Protective Hands* for a SAFE LANDING!

A critical moment — as plane and ground meet. If vagaries of wind and timing make the meeting a rough one, the landing gear must safely absorb severe impact.

At points of greatest stress and shock in the landing gear of plane after plane, AMPCO METAL is used . . . undeniable proof of the greater strength and longer wearing qualities of this dependable bronze.

SPECIFIED *for the* "TOUGH" JOBS

In other industries, as in aviation, you'll find AMPCO METAL widely used wherever exceptional durability and resistance to impact, fatigue, wear and corrosion are required. It enjoys a unique reputation as "the metal that makes good when all others fail."

Have You a Problem of "Metal Failure"?

Maybe AMPCO METAL can master a troublesome job for you. It's made in many grades and forms. Tell our engineering staff what you're up against, and they'll be glad to supply complete data and recommendations. There's no obligation. Write

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The Metal Without An Equal

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MAGNESIUM ALLOYS

THE LAST WORD IN LIGHTNESS

MAZLO DIE CASTINGS...

cut the cost of going very light

MAZLO Magnesium Alloys provide an inexpensive means of saving weight. This lightest of commercial metals weighs only one-fourth as much as iron. Costs per piece, therefore, are surprisingly moderate.

MAZLO die castings give you smooth surfaces, accurate dimensions, and small draft. Very little finishing is required. Walls can be thick or thin. Parts can be quite complicated. Die costs are not high.

"MAZLO" stands for a practical family of Magnesium Alloys, variety of commercial forms, completeness of manufacturing facilities, and experience in fabricating methods. "MAZLO" is the name to know in Magnesium. Sales Agent: Aluminum Company of America, 1703 Gulf Building, Pittsburgh, Pennsylvania.

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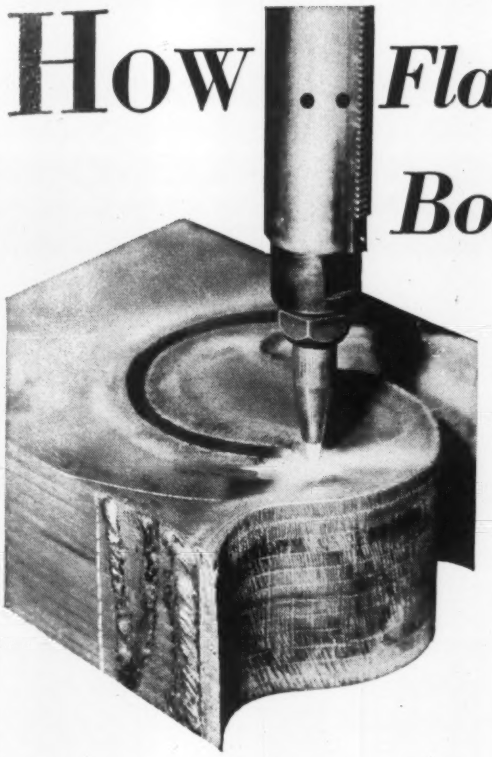
AMERICAN MAGNESIUM CORPORATION

HOW . . *Flame-Cutting Overcomes Bottlenecks in Production*



WITH PRODUCTION schedules soaring to unprecedented heights, oxy-acetylene flame-cutting is a fast and economical answer to the need for shaping steel. This flame quickly slices through heavy plate, light gauge sheet, and billets, slabs, or forgings—in straight lines, circles, or irregular shapes. In addition, it cuts through tightly clamped stacks of plate as shown at the left. Some of the ways in which this versatile process overcomes production bottlenecks are outlined here.

MACHINING TIME and expense can be materially reduced—and in some cases completely eliminated—by flame-cutting, thus relieving men and machine tools for other work.

LESS DEPENDENCE on outside sources of supply for fabricated parts is made possible by the ability to make what you need as you need it.

DESIGN CHANGES can be made quickly, without loss of time or money for new dies, molds, or patterns. Change-overs on flame-cut parts are only a matter of minutes.

PARTS INVENTORIES can be held down, because almost any parts can be produced immediately as needed from stock steel.

SAVINGS IN WEIGHT and bulk, and in most cases, increase in strength over parts fabricated by older methods are made possible by use of flame-cut, or flame-cut and welded, parts.

OPERATORS of flame-cutting machines can be trained to do good work in a short time. The investment required for equipment is moderate.

ONE-OF-A-KIND production for replacement or new-model development work is economically practical with flame-cutting, and is usually much faster than by other methods.

QUANTITY PRODUCTION can be facilitated by cutting numerous parts simultaneously—either by "stack-cutting" or by multiple blowpipe operation.

and Linde can help you apply it!

• Linde can supply the gases, machines, and other essential materials for using flame-cutting, with the assurance of dependable, uninterrupted deliveries. In addition, Linde has the process ability and the organization to render on-the-job assistance that helps customers use flame-cutting effectively. For the full story, *send the coupon!*

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Unit of Union Carbide and Carbon Corporation
New York and UCC Principal Cities
In Canada: Dominion Oxygen Company, Limited, Toronto

MD-10
The Linde Air Products Company
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☐ Please send me literature describing Oxweld flame-cutting machines.
☐ Please ask a representative to come to my office to supply further information on Flame-Cutting and Linde Process Service.

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COMPANY..
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Attend American Welding Society's annual meeting . . . . and National Metal Exposition . . . . at Cleveland during October 21 to 25 . . . . Hear authorities discuss latest welding and cutting developments . . . . See the new apparatus and equipment . . . . Exchange ideas with other experts . . . . Write now for program.

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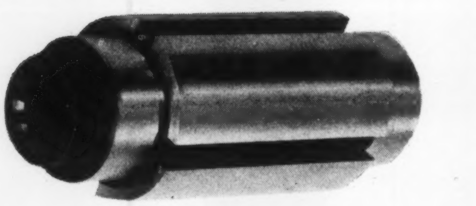
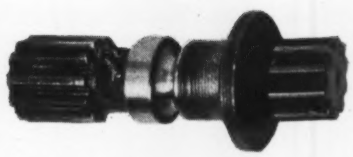
THE HARDEST KNOWN STEEL SU

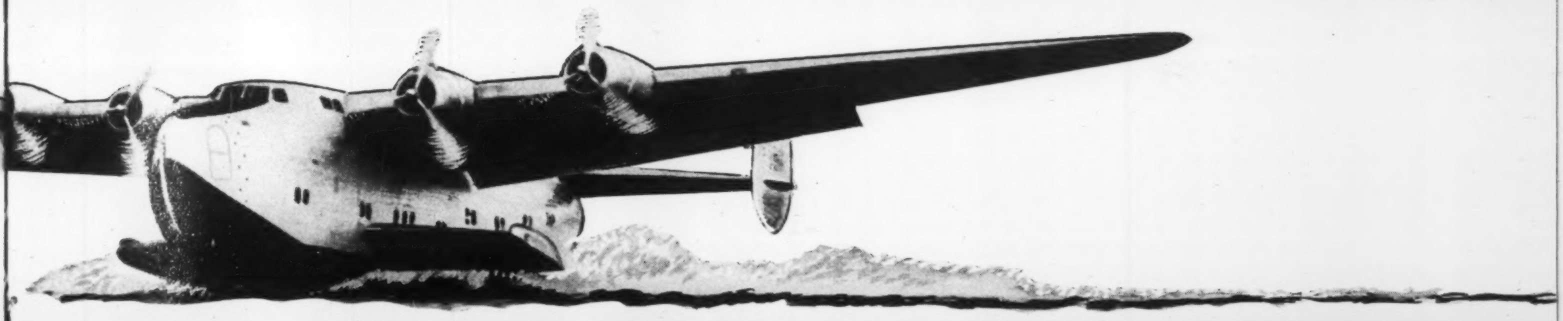
PESCO FUEL PUMP





FROM the day Boeing American transatlantic clipper made its first trip across the ocean, Pump Engineering Service Corporation's aircraft fuel pumps as illustrated have been used in the four Wright cyclone engine motors which power these clippers.

Nitralloy Steel was specified for use in two of the most important parts of these aircraft pumps—the rotor and drive couplings (illustrated here)—



ALLOY

SURFACE FOR WEAR RESISTANCE!

because according to Pump Engineering's chief engineer "It wears longer than any other similar material even with no lubrication other than what little may be derived from the fuel passing through the pump."

Nitralloy is also used in the cylinder barrels, gears and other important parts of the clipper's motors because Nitralloy presents a minimum of distortion and a maximum of wear resistance along with its tremendous durability. Just another of the many phases of industry that has accepted Nitrided Nitralloy to give longer life to vital machine parts.

For information write the Nitralloy Corporation or any of its listed licensees.

THE NITRALLOY CORPORATION

230 PARK AVENUE NEW YORK, N. Y.

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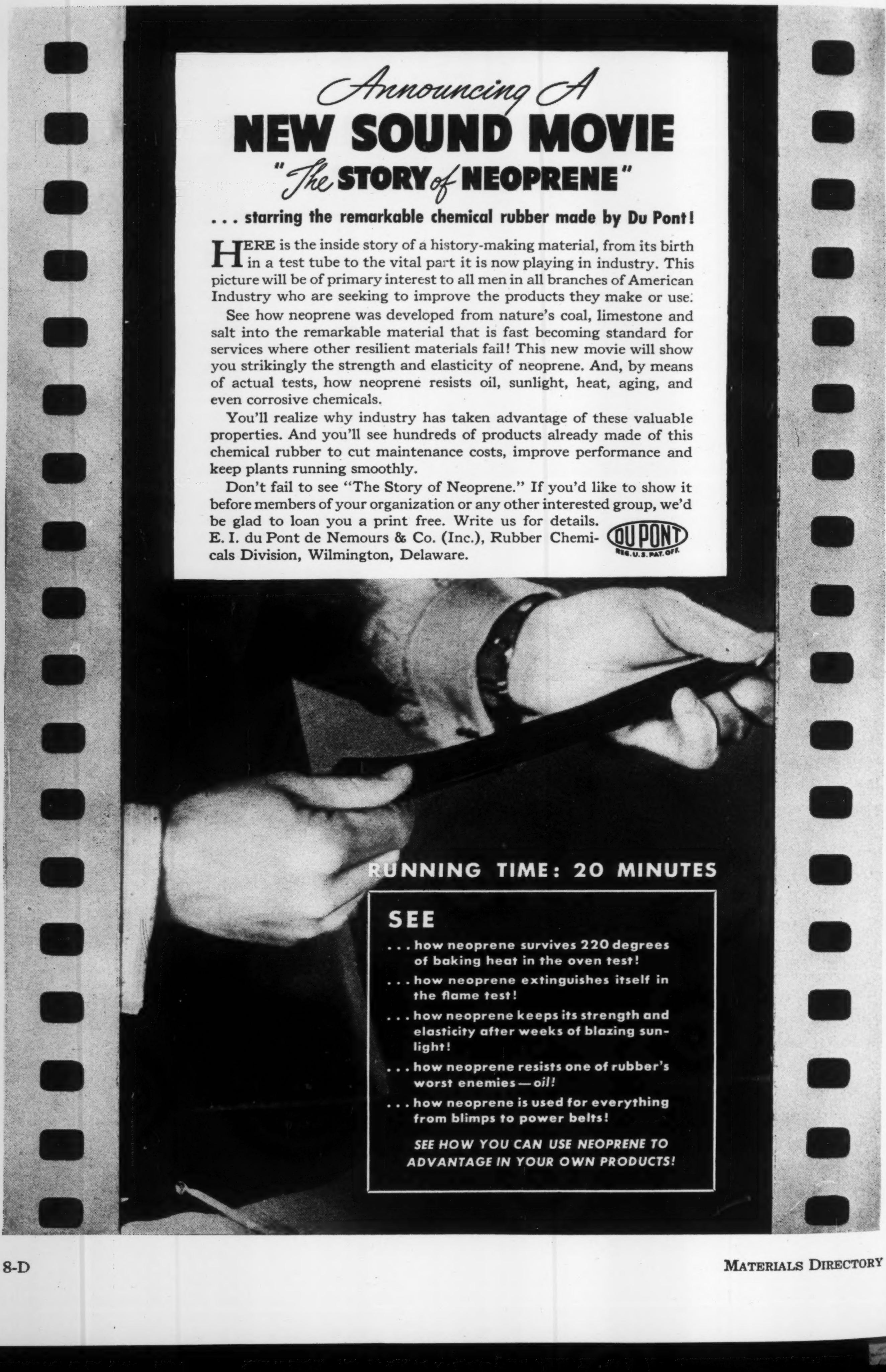

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"*The* STORY *of* NEOPRENE"

. . . starring the remarkable chemical rubber made by Du Pont!

HERE is the inside story of a history-making material, from its birth in a test tube to the vital part it is now playing in industry. This picture will be of primary interest to all men in all branches of American Industry who are seeking to improve the products they make or use.

See how neoprene was developed from nature's coal, limestone and salt into the remarkable material that is fast becoming standard for services where other resilient materials fail! This new movie will show you strikingly the strength and elasticity of neoprene. And, by means of actual tests, how neoprene resists oil, sunlight, heat, aging, and even corrosive chemicals.

You'll realize why industry has taken advantage of these valuable properties. And you'll see hundreds of products already made of this chemical rubber to cut maintenance costs, improve performance and keep plants running smoothly.

Don't fail to see "The Story of Neoprene." If you'd like to show it before members of your organization or any other interested group, we'd be glad to loan you a print free. Write us for details.
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RUNNING TIME: 20 MINUTES

SEE

- **. . . how neoprene survives 220 degrees of baking heat in the oven test!**
- **. . . how neoprene extinguishes itself in the flame test!**
- **. . . how neoprene keeps its strength and elasticity after weeks of blazing sunlight!**
- **. . . how neoprene resists one of rubber's worst enemies—*oil!***
- **. . . how neoprene is used for everything from blimps to power belts!**

SEE HOW YOU CAN USE NEOPRENE TO ADVANTAGE IN YOUR OWN PRODUCTS!

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BEARINGS
Any Size..Any Type
Any Quantity

PRECISION - - - - QUALITY - - - - SERVICE

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● There is one RIGHT bearing for every application. When you base your selection entirely on operating conditions — speeds, load, lubrication — you are assured of the maximum in performance, bearing life and economy.

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JOHNSON BRONZE COMPANY
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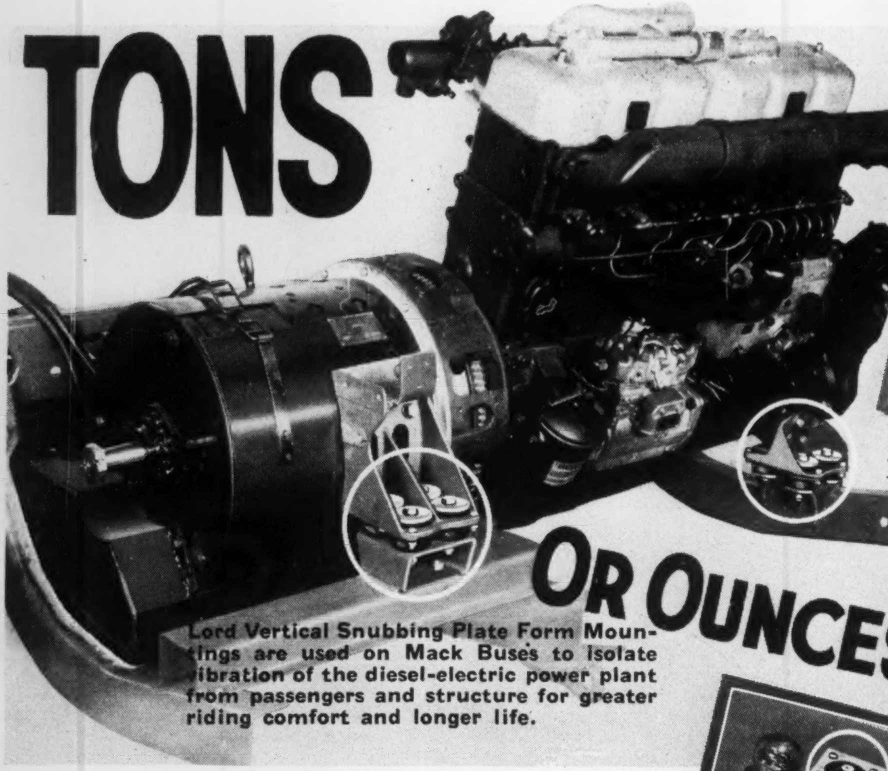
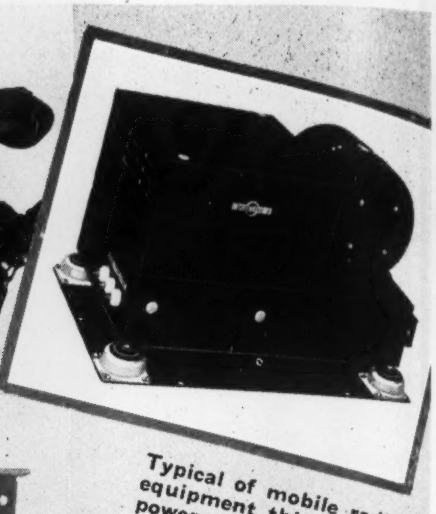


OR OUNCES

Lord Vertical Snubbing Plate Form Mountings are used on Mack Buses to isolate vibration of the diesel-electric power plant from passengers and structure for greater riding comfort and longer life.



Typical of mobile radio equipment this aircraft power supply unit of the Collins Radio Company is supported on Lord Holder Type Plate Form Mountings for protection against outside shock and vibration.

It's a big jump from diesel-electric units to radio tubes. One of the three Lord Mountings used in the Sanborn Cardiette is shown. They serve to insulate the amplifier assembly both electrically and mechanically from the rest of the instrument.

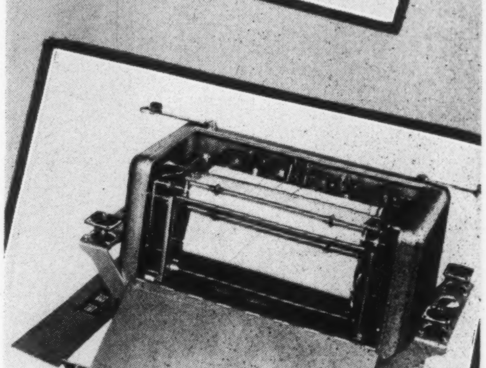
LORD *Shear Type* MOUNTINGS *for* VIBRATION CONTROL

Of the many applications of Lord Bonded Rubber Mountings we list a few to illustrate the range they cover: automotive, marine and aircraft engines, motors, generators, pumps, compressors and printing presses to touch some in the heavier units; instruments, radio equipment and sensitive apparatus down to a single radio tube in the lighter classifications.

Lord's wide engineering experience in vibration control can help you select from the great variety of standard mountings available or in adapting them to meet your requirements.

HEADQUARTERS
for
VIBRATION
CONTROL

LORD MFG. CO.
ERIE, PA. - - - U. S. A.



Julian P. Friez & Sons Flight Analyzers, Lord mounted, in the tail of aircraft, record all vital flight functions. Two Lord Plate Form Mountings in series are used at each point of support.

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It takes rubber in shear to absorb vibration

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the first complete volume written by a recognized engineer—for engineers. Potentialities as well as limitations for all plastic materials are fully covered in terms of the various engineering problems involved. Progress of art and extent of applications are emphasized. Tests conducted by the author support the discussion with conveniently tabulated data.

Physical, chemical and electrical properties are discussed. Included are numerous tables of comparative data and critical evaluation of the single properties of each plastic.

Comprehensive analyses of compression, transfer, injection and cold molding are included. Molding techniques are compared with respect to material selection, economies and various practical problems which may arise. Factors contributing to the costs of molding operations are analyzed. Various methods of finishing are treated and specific recommendations made for different types of work. Information on correct design procedures for molded parts is presented in useful, ready reference manner.

Properties and methods of fabricating various stocks of plastics are discussed with respect to machining, forming, hot swaging, punching and finishing. Particularly significant are the chapters on cast synthetic resins and transparent plastic materials.

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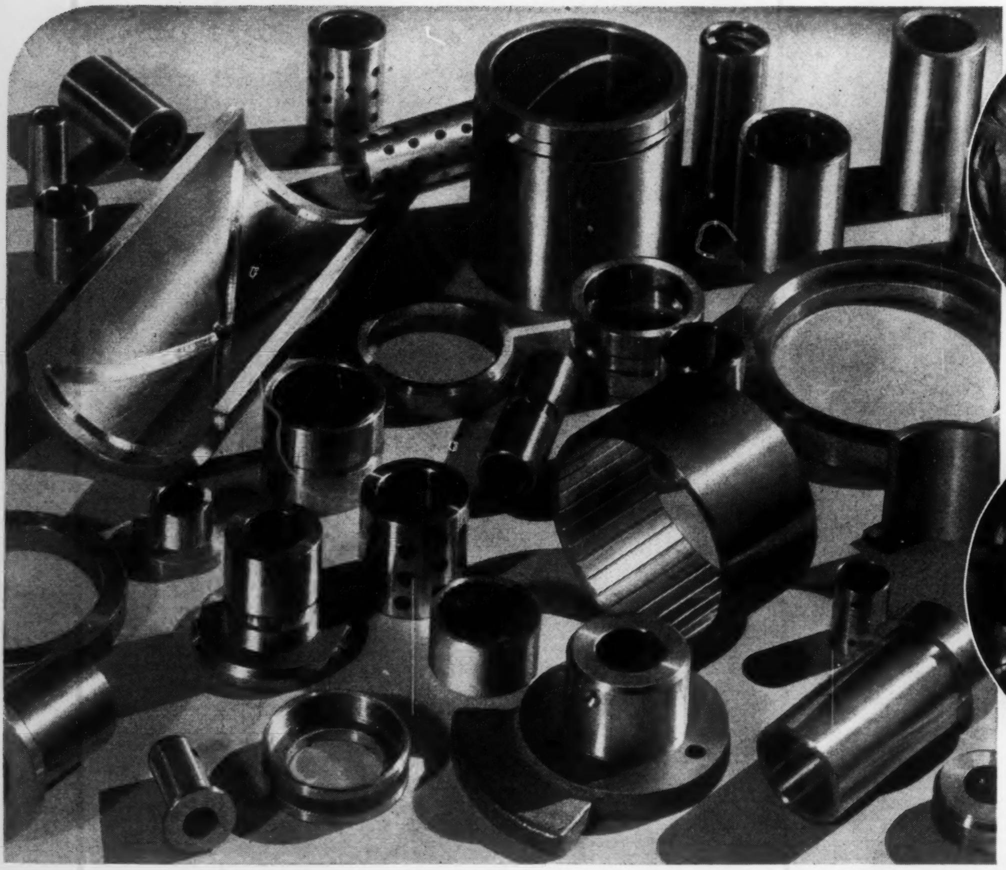
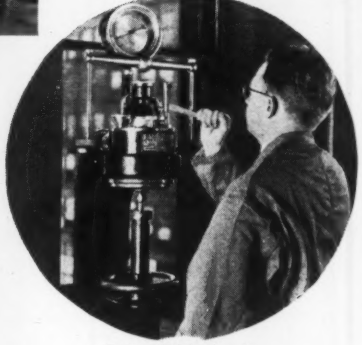


Chemical Testing to Check Metal Analysis

Micro-photographing the Grain Structure



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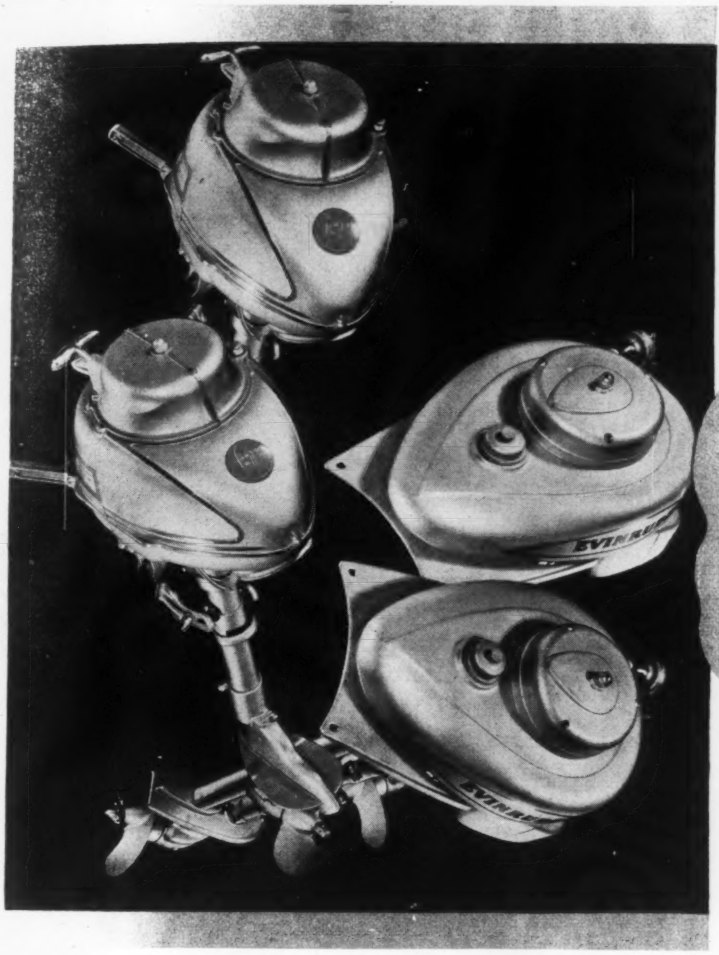

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For low-cost protection of Aluminum and its alloys, consider Alrok finishes (process patented). They have proved popular for such products as outboard motors, comptometer cases, aircraft parts and gas tanks, machine parts and dental equipment. They make an excellent surface preparation for painting.

Alrok finishes are inexpensive because they are produced by chemical processes and require very little special equipment. While costing less than the harder electro-chemical finishes, Alrok finishes are decorative and provide resistance to corrosion that is satisfactory for many purposes.

The booklet, "Finishes for Aluminum", which includes information on mechanical finishing as well as electrolytic and chemical finishes, will assist in solving your Aluminum finishing problems. Send for a free copy. ALUMINUM COMPANY OF AMERICA, 1940 Gulf Building, Pittsburgh, Pa.

* Process Patented

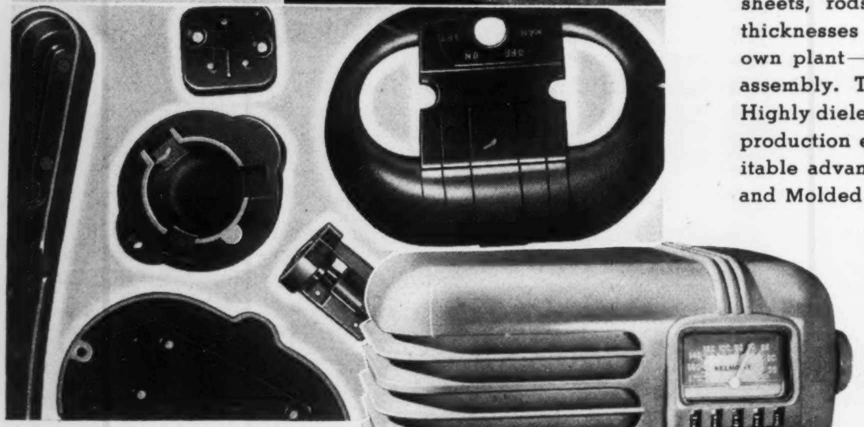
IT IS NEVER COSTLY TO USE ALCOA ALUMINUM RIGHT

ALCOA ALUMINUM

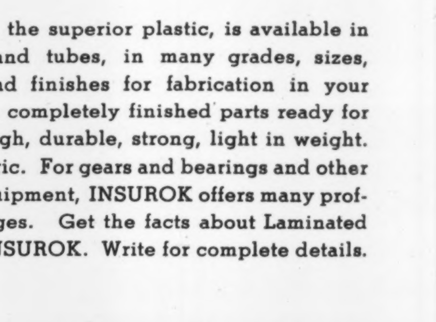
RICHARDSON PLASTICS for master designers and product engineers

Unbelievably diversified are the uses of Richardson plastics by engineers and designers in countless products and manufacturing equipment. In steel, paper, textiles, foods, ink, chemicals, printing, transportation, paint, floor coverings, electrical, communications, automotive and other industries, Richardson plastics are giving outstanding service, and suggesting further uses for these versatile materials. Consult Richardson engineers about any plastics application you have under consideration.

INSUROK, the superior plastic, is available in sheets, rods and tubes, in many grades, sizes, thicknesses and finishes for fabrication in your own plant—or completely finished parts ready for assembly. Tough, durable, strong, light in weight. Highly dielectric. For gears and bearings and other production equipment, INSUROK offers many profitable advantages. Get the facts about Laminated and Molded INSUROK. Write for complete details.



Radio by Belmont Radio Corp.



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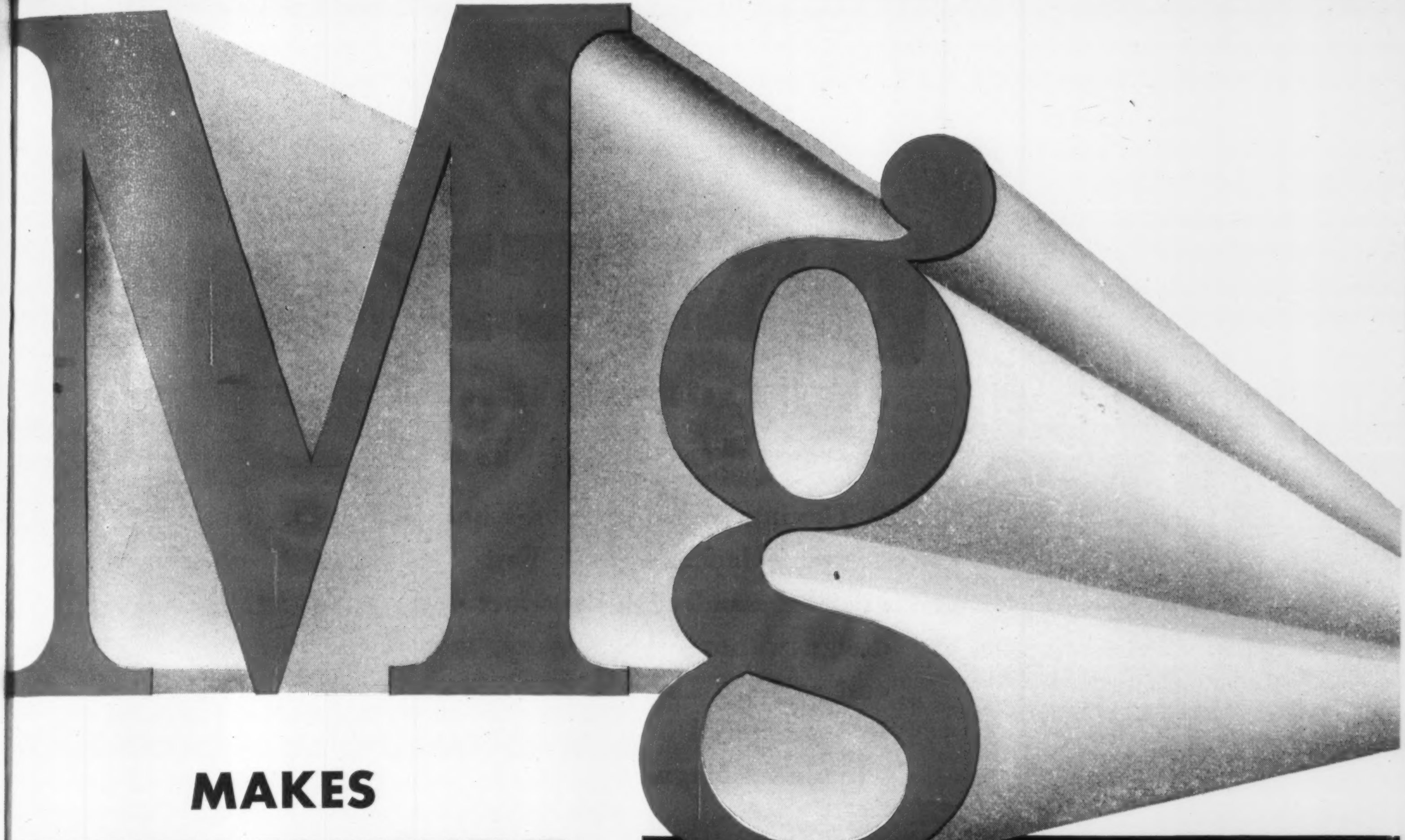

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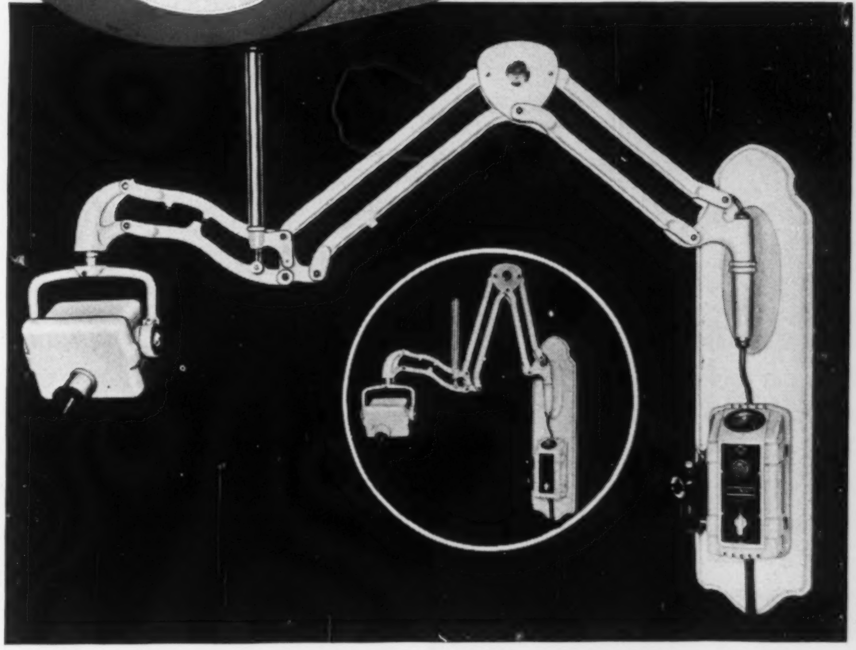
The Fisher Wall-Mounted Dental X-Ray Apparatus s designed with flexible extension arms so that it can e instantly adjusted to any position.

These arms are made of DOWMETAL*, which is an lloy of Mg (magnesium)—a metal that is a full hird lighter than any other in common use. In thus liminating useless weight the designers attained a aximum ease of operation—an advantage highly esirable in dental work.

This is just one more example of the wide-spread cceptance of DOWMETAL Magnesium Alloys for aried applications. Amazing lightness, together with xceptional durability and toughness, make magneium (Mg) the most useful of all structural metals.



The flexible extension arms of this Fisher Dental X-Ray Apparatus are made of DOWMETAL Sand Castings by Hills-McCanna Co. They eliminate weight and assure ease of adjustment.

DOWMETAL Magnesium Alloys are available in sand, die and permanent mold castings, forgings, sheet, strip, plate, bars, tubes, structural and special extruded shapes. Write for any information desired.

DOWMETAL

MAGNESIUM ALLOYS

LIGHTEST OF ALL STRUCTURAL METALS

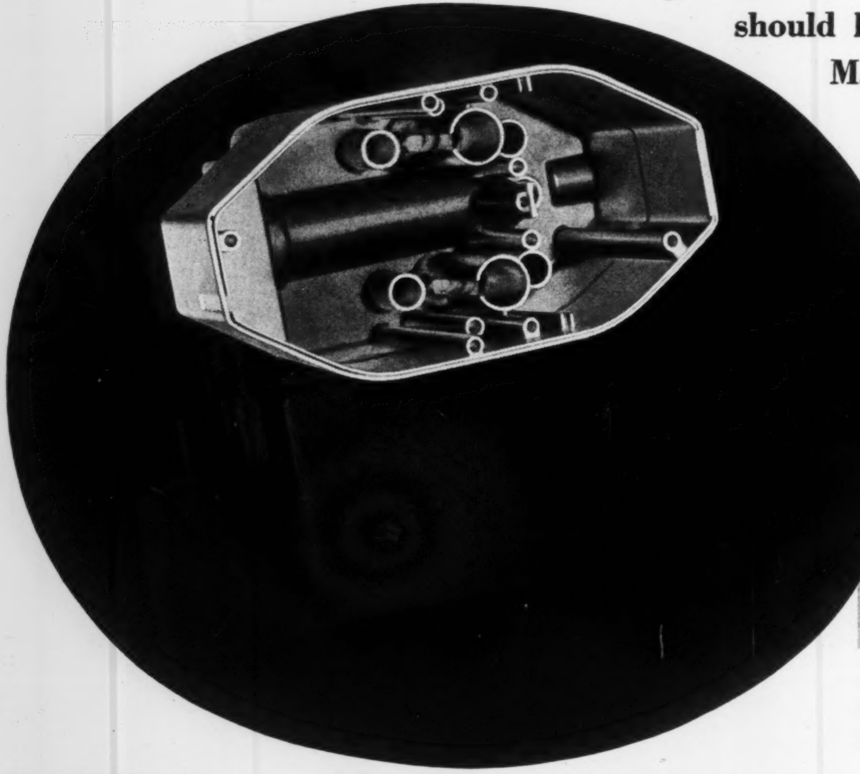
THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN
Branch Sales Offices: New York City, St. Louis, Chicago,
San Francisco, Los Angeles, Seattle.

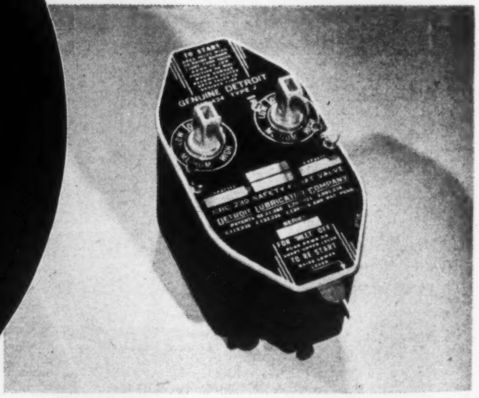
*Trade Mark Reg. U. S. Pat. Off.

Kipp DIE CASTINGS

...Afford Almost Complete Freedom of Design

● The ingenious Madison-Kipp Die Casting Dies and Die Casting Machines and Fast Trimming Fixtures have afforded hundreds of product designers great freedom of design without cost penalty, and often with an over-all cost saving. The Madison-Kipp Die Casting Department is experienced in handling all die casting alloys of Zinc, Aluminum Magnesium or Brass. Blue prints and samples should be sent to the home office in Madison where all recommendations and estimates are made.





• *An unusual example of clever control instrument designing, by Detroit Lubricator Co. of Detroit, Mich.*

MIRROR REFLECTION PHOTOGRAPH SHOWING TWO SIDES OF MADISON-KIPP CASTING

Madison-Kipp

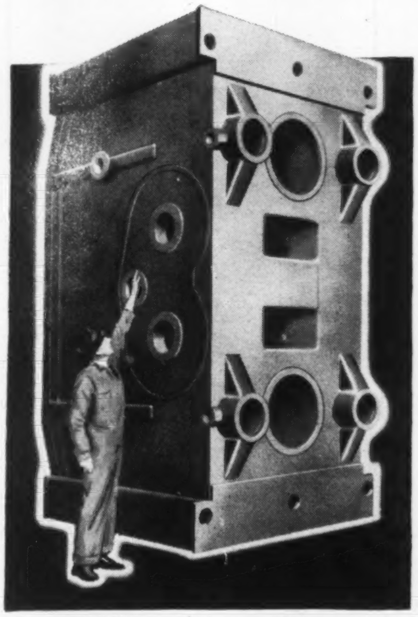
CORPORATION

210 Waubesa St., Madison, Wis., U. S. A.

Complete
DIE CASTING SERVICE
FRESH OIL LUBRICATORS
HIGH SPEED AIR
TOOLS

SIMPLIFY AND SPEED UP CONSTRUCTION

with Welded Rolled Steels



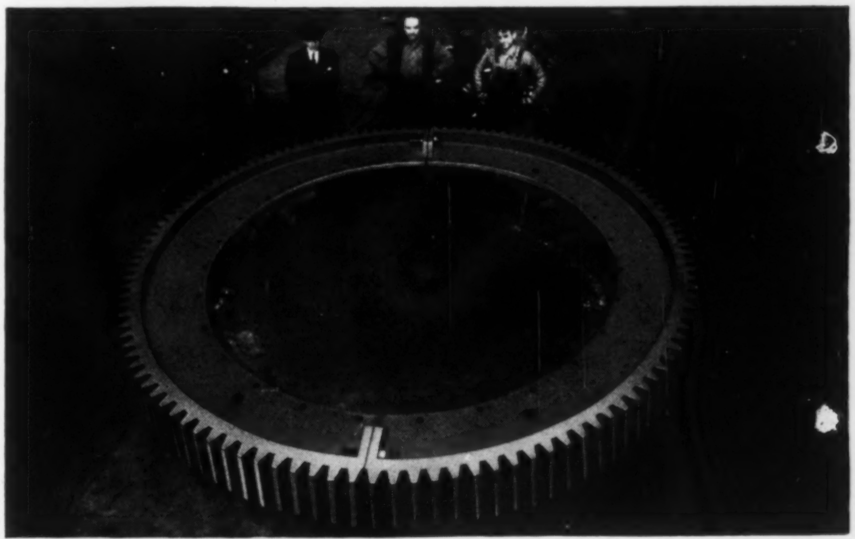
Only 12 days were required *for complete fabrication of this stamping press crown with rolled steel construction. Time saving is one of the many cardinal advantages in the use of rolled steel for machine construction. Immediate execution of the design is possible. There are no delays for parts or patterns. In this case weight was reduced 55%.*

TODAY industry is facing the call for drastic increases in production. Manufacturers everywhere are being asked to swing over to new and unfamiliar products. Time is a vital factor. And to meet this emergency, more and more plants are turning to rolled steel construction—because no other method of fabrication offers the same advantages of speed and economy.

Seemingly impossible jobs can be finished in a hurry with welded rolled steel construction. Time and expense are saved by the elimination of patterns and cores. Designs can be "carpentered in steel" direct from blue prints. "In progress" alterations can be made quickly and easily. The work is half way to completion when you use rolled steel—a thoroughly worked product free from blow holes and other imperfections, ready for immediate fabrication.

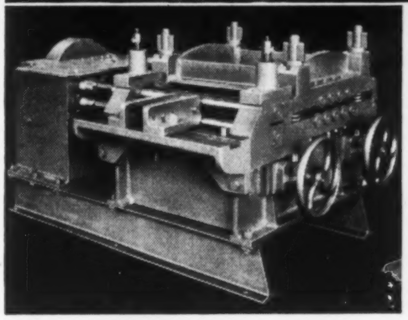
Using rolled steel construction puts the entire range of metallurgy's special steels at your disposal. They may be readily combined with one another, or with plain steel or castings, to improve your product, to give it greater strength and less weight, to reduce its cost. Equipment can be designed with its true functional requirements in mind—every part can be made to perform at fullest efficiency.

Are you taking full advantage of the special steels now available? Why not consult a U·S·S engineer on the best ways to use them? His advice and assistance are yours without obligation.



Completed in one week, *this 11,600 pound gear, with an inside diameter of 9′ 11¼″, is proof of the speed possible with rolled steel construction. Experience in previous similar jobs showed that it would have required nearly a month to build the same gear with other methods of fabrication.*

• • • •



Time saved 50%. *The Goodman Manufacturing Co., Chicago, Ill. used rolled steel plates and structural sections for all parts of this roller leveler except the top roller housing and front guide portions; cast elements are cast steel. The results were greater strength per unit of weight, 15% saved in weight, 5% saved in cost.*

For faster construction and longer-wearing equipment

fabricate with these better steels

U·S·S Cor-Ten — to resist corrosion; to reduce weight or increase strength.

U·S·S Man-Ten — to increase strength without adding weight.

U·S·S Abrasion Resisting Steel—for use where abrasive conditions are exceptionally severe.

U·S·S Heat Resisting Steel—to combat high temperatures.

U·S·S Stainless Steel—to resist corrosion of all kinds.

U·S·S Carilloy Alloy Steels—to carry tremendous bearing pressures.

CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*
United States Steel Export Company, New York

THE UNITED STATES STEEL BUILDING
VISIT
USS
NEW YORK WORLD'S FAIR · 1940

UNITED STATES STEEL

Aircraft Bearings

● Bunting is completely equipped to meet the demands of the aircraft industry for precision-built bearings made of cast and wrought bronzes. Exact dimensional detail is provided by the most modern machining methods. Fineness of finish is assured by surface contour readings gauged to micro inches. Bunting responsibility and experience go back to the earliest days of aircraft production. Send us your blueprints for quotations. The Bunting Brass & Bronze Company . . . Toledo, Ohio.

Warehouses in All Principal Cities.

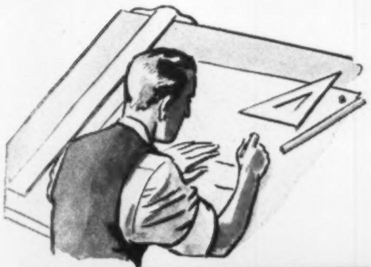
Let Bunting help you design your bearings. Our mechanical, metallurgical and research engineering staffs and equipment are available to you, without cost or obligation, for development work in bearing alloy and design.

MADE TO BLUE PRINT

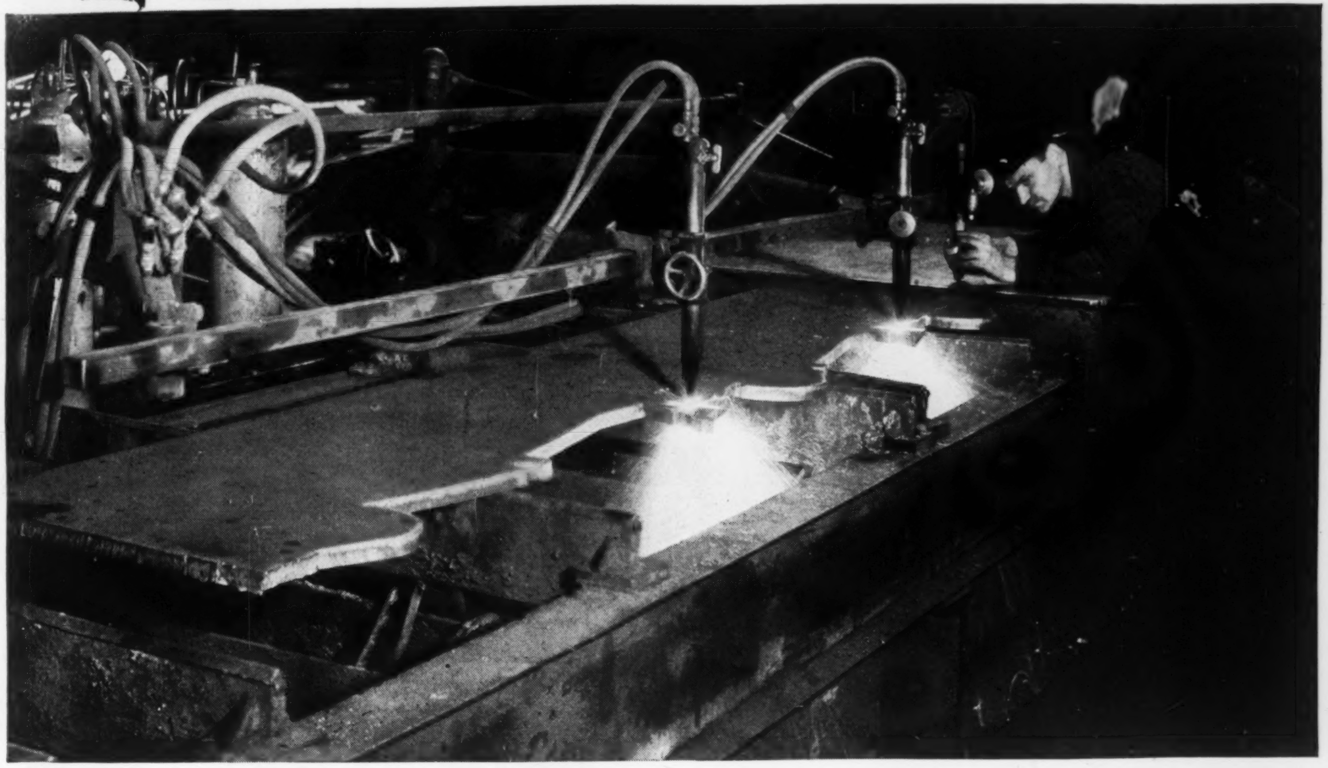
BUNTING

BRONZE BUSHINGS • BEARINGS
PRECISION BRONZE BARS • BABBITT METALS

DESIGN FOR WELDING



. . . and take full advantage of simultaneous multiple cutting



Equipment is a one-piece unit *when assembled by welding.* It weighs less — yet is rugged enough to withstand severe shock and strain. Products designed for welding are also economical — particularly when constructed with flame-cut parts. Additional economies can often be earned by simultaneous multiple cutting.

Where quantities of parts are required—whether large or small — the Airco line of cutting machines make welded construction more profitable. Here, an Oxygraph illustrates the economies possible by cutting hinges for clam shell buckets, two at a time, in the Wellman Engineering Company's Cleveland Plant. » » » Design your product for welding — remember, Airco can help you get the most out of machine gas cutting and also from welding, both by the oxyacetylene and the electric arc processes. Write for full details.

AIR REDUCTION

General Offices: 60 EAST 42nd ST., NEW YORK, N. Y. DISTRICT OFFICES IN PRINCIPAL CITIES

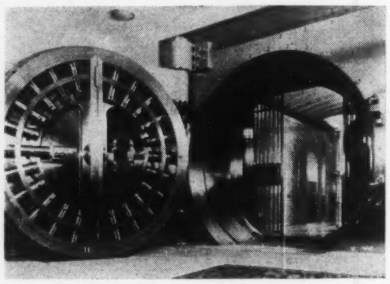
AIRCO *Anything and Everything for* GAS WELDING or CUTTING and ARC WELDING WILSON

PROTECT YOUR PRODUCT WITH STEEL CASTINGS

Modern fire-fighting equipment—efficient, streamlined, dependable—is protected through the generous use of steel castings for important working parts. All of the lift members of this new American LaFrance ladder truck are cast alloy steel—"for utmost strength and resistance to shocks."

Here, where failure of any part might mean disaster or loss of life, steel castings give the same kind of permanent strength and stability they will contribute to your own product.

Steel castings have other advantages for you, too. They save on machining and assembly time, permit metal distribution for greatest strength exactly where needed, afford a wide range of mechanical properties, and lower over-all weight.



Safety deposit vault doors and fittings, and thousands of other products, give better protection because an increasing number of steel castings are used to build them.

Consider steel castings for your product. They will bring you improved quality, plus increased strength and safety . . . often at lower cost. Consult your own foundry, or write to Steel Founders' Society, 920 Midland Bldg., Cleveland, Ohio, for further details and recommendations. No obligation.

MODERNIZE YOUR PRODUCT WITH

STEEL CASTINGS

Directory of Materials

SUPPLEMENT TO MACHINE DESIGN'S OCTOBER 1940 ISSUE

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Plastics and other Nonmetallics 43-D

Alphabetical Listing of Producers of Design Materials

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Die Castings Producers 68-D

Custom Molders of Plastics 70-D

Machine Finishes and Producers 74-D

This new, revised and expanded edition of MACHINE DESIGN'S "Directory of Materials" contains the latest available information on all types of materials, their properties and sources of supply. Useful data in condensed form is arranged in this directory for ready reference by chief engineers and designers of machinery manufacturing companies.

Now in its eighth edition, the directory includes a new section on finishes for machines and machine parts. Listed under each manufacturer are all nationally distributed metallic and nonmetallic paints, varnishes, lacquers, enamels and plated finishes. Each listing is concisely treated with respect to characteristics of the finish, how applied, method of drying, and where used. Tradenames are included.

Both the metallic and nonmetallic sections (in line with earlier editions) are cross referenced with a separate listing of producers' names, facilitating the use of the directory. Also, a convenient key of numerals is used above each listing in these sections to classify the properties of the materials and to aid in their selection.

As in previous issues, the directory is stitched into the magazine proper in such a way that it can be removed conveniently for filing, without damage either to the magazine or directory.

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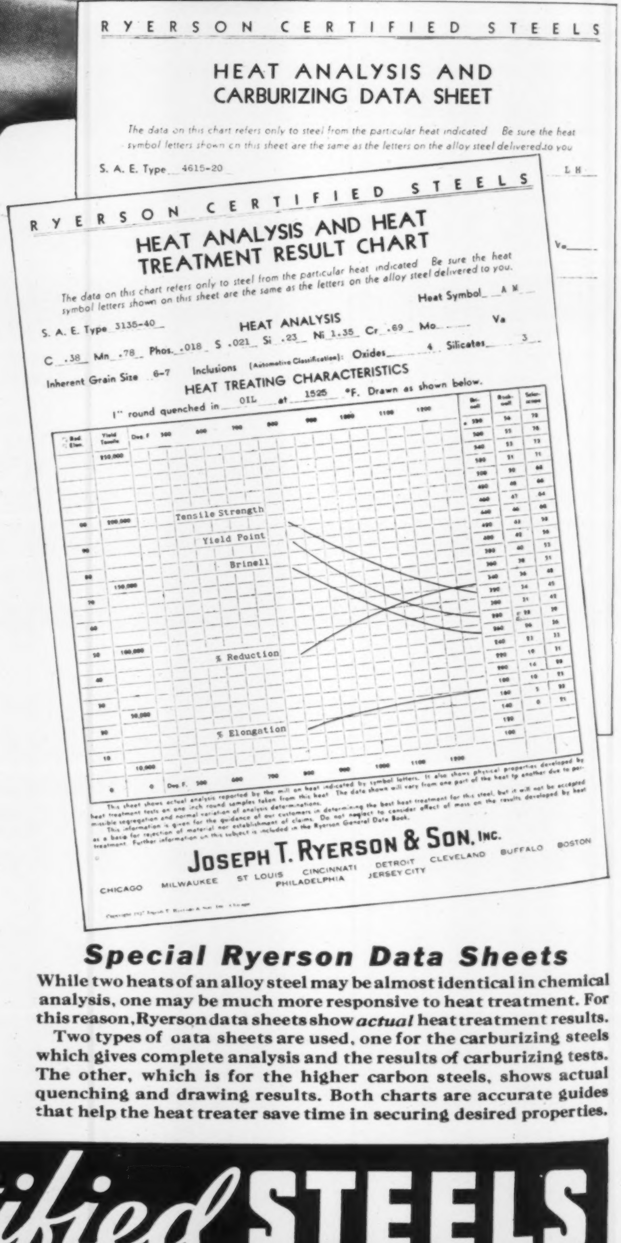
Valuable Data at No Extra Cost

RYERSON
RYERSON CERTIFIED STEELS
Important Heat Treatment Data


RYERSON CERTIFIED STEELS

HEAT ANALYSIS AND
CARBURIZING DATA SHEET

The data on this chart refers only to steel from the particular heat indicated. Be sure the heat symbol letters shown on this sheet are the same as the letters on the alloy steel delivered to you

S. A. E. Type 4615-20 L H

RYERSON CERTIFIED STEELS

HEAT ANALYSIS AND HEAT
TREATMENT RESULT CHART

The data on this chart refers only to steel from the particular heat indicated. Be sure the heat symbol letters shown on this sheet are the same as the letters on the alloy steel delivered to you.

Heat Symbol A M

S. A. E. Type 3135-40 HEAT ANALYSIS

C .38 Mn .78 Phos. .018 S .021 Si .23 Ni 1.35 Cr .69 Mo Va

Inherent Grain Size 6-7 Inclusions (Automotive Classification): Oxides 4 Silicates 3

HEAT TREATING CHARACTERISTICS

1" round quenched in OIL at 1525 °F. Drawn as shown below.

This sheet shows actual analysis reported by the mill on heat indicated by symbol letters. It also shows physical properties developed by heat treatment tests on one inch round samples taken from this heat. The data shown will vary from one part of the heat to another due to permissible segregation and normal variation of analysis determinations.

This information is given for the guidance of our customers in determining the best heat treatment for this steel, but it will not be accepted as a basis for rejection of material nor establishment of claims. Do not neglect to consider effect of mass on the results developed by heat treatment. Further information on this subject is included in the Ryerson General Data Book.

JOSEPH T. RYERSON & SON, INC.

CHICAGO MILWAUKEE ST LOUIS CINCINNATI DETROIT CLEVELAND BUFFALO BOSTON PHILADELPHIA JERSEY CITY

Immediate Stock Shipment of Uniform High Quality Steels . . .

When you need steel—whether a single bar or a carload—you can depend on Immediate Shipment from the wide range of Certified Steel products carried in stock at a nearby Ryerson plant. More than 10,000 kinds, shapes and sizes of steel and allied products permit you to select steels particularly suited to every application. Modern facilities and improved methods for cutting and otherwise preparing steel assures accuracy and speed on all orders.

Under the Ryerson certification plan, every pound of steel carried in stock represents the highest quality in each particular class. A special quality control plan on Alloy Steels assures uniform heat treatment response. Complete chemical and physical properties, and the exact heat treating characteristics of each bar are sent with the steel to guide the heat treater in securing dependable, uniform results. He does not have to test. He takes no chances. Spoilage and re-treating are eliminated and a sound, dependable job of high accuracy and uniformity is assured.

If you do not have the current Ryerson Stock List—the Guide to Immediate Steel—we will gladly send a copy.

Joseph T. Ryerson & Son, Inc., Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia, Jersey City.

Special Ryerson Data Sheets

While two heats of an alloy steel may be almost identical in chemical analysis, one may be much more responsive to heat treatment. For this reason, Ryerson data sheets show *actual* heat treatment results.

Two types of oata sheets are used, one for the carburizing steels which gives complete analysis and the results of carburizing tests. The other, which is for the higher carbon steels, shows actual quenching and drawing results. Both charts are accurate guides that help the heat treater save time in securing desired properties.

RYERSON *Certified* STEELS

Iron, Steel and Nonferrous Metals Listed by Tradenames

(For listing by producing companies, and complete street addresses, see Page 49-D)

A

1 - 3 4 - - - - - -

ABRASOWELD—Lincoln Electric Co., Cleveland. Arc-welding electrode for providing abrasion resisting, self-hardening deposit which hardens rapidly under impact and abrasion; maximum hardness develops at surface, leaving cushion of softer metal beneath, provides resistance to abrasion in straight carbon, low alloy or high manganese steel surfaces; effective on gear and pinion teeth.

1 - - - - - - - - -

ACME COLORSTRIP—Acme Steel Co., Chicago. Strip steel, electro-galvanized and coated on one or both sides with any specific color (coating may be either enamel or lacquer); furnished in coils and can be fabricated by rolling or stamping; corrosion resistant; resists heat up to 150 degrees Fahr.; same tensile strength, elongation and hardness same as any strip steel with slight variations depending on temper and analysis of the base metal.

- - - 4 5 6 - - - -

ACORN—A. W. Cadman Mfg. Co., Pittsburgh; babbitt metal furnished in ingots; brinell hardness 70 degrees Fahr. 23.8, 212 degrees Fahr. 21.8; compressive strength 12,500 lbs. per sq. in.; for bearings having reciprocating motion, subject to excessive pound or vibration.

- - - - - 6 - - - -

ADAMANT SUPER-GENUINE BABBITT—Magnolia Metal Co., Elizabeth, N. J. Over 90 per cent tin, free of lead, containing special fluxes; furnished as ingots; specific gravity 7.34; bearing properties good; brinell hardness, untreated 23; used for bearings, diesel engines, connecting rods, etc., subject to shock or strain.

- - 3 - - - - - - -

ADAMANTINE—Babcock & Wilcox Co., New York. Special steel castings with wear-resisting qualities and machinable surfaces; for grinding mills, mixers, conveyors, power shovels.

- - 3 - - - - - - -

ADAMITE — Mackintosh-Hemphill Co., Pittsburgh. Alloy steel characterized by strength plus wear resistance.

- 2 - - - - - - - -

ADAMITE IRON — Mackintosh-Hemphill Co., Pittsburgh. A wear and heat resistant iron.

1 - - - - - - - - -

ADMIRALTY METAL, Bulldog Brand—Phelps Dodge Copper Products Corp., New York. Copper 70, zinc 29, tin 1, furnished in tubing, sheets and strips for extruding, welding and drawing; corrosion resistant; resists heat to 45 degrees Fahr.; tensile strength 45,000-95,000 lbs. per sq. in.; high ductility; for condenser tubes.

1 2 - - 5 - - - - -

ADNIC—Scovill Mfg. Co., Waterbury, Conn. Copper 70, nickel 29, and tin 1; furnished in rods, bars, tubes, wire, sheets, strips and plates for stamping, turning, boring, welding, deep drawing, cold heading, and brazing: resists corrosion due to organic acids, alkalies, sulphur compounds; resists heat up to 600 deg. Fahr.; tensile strength 55,000 to 130,000 lbs. per sq. in.; recommended heat treatment, annealing, 1100 to 1300 deg. Fahr.; brinell hardness, untreated, 70 to 200; used for condenser tubes and heat exchanger tubes.

- 2 - - - - 7 - - -

ADVANCE—Driver-Harris Co., Harrison, N. J. Copper 55, nickel 45; resists heat up to 1500 degrees Fahr.; thermocouple material. For application where low temperature coefficient of resistivity is required; also for measuring instruments, industrial and radio rheostats and elevator controls.

- - - 4 - 6 - - - -

AERISWELD—Lincoln Electric Co., Cleveland; arc-welding electrode; for welding of bronze, brass and copper either in manufacturing or maintenance work.

1 - 3 - - 6 - - - -

AETERNA 600 METAL—Allied Process Corp., New York. 60:40 brass base with manganese and silicon; furnished in rough bars or billets, finished rods or bars and tubing for hot forging and extruding; corrosion and abrasion resistant; tensile strength 85,000 lbs. per sq. in.; medium ductility; good bearing properties and weldability; used for gears, levers, cams, cranks, etc.

1 2 - - - 6 - - - -

AGRICOLA—Saginaw Bearing Co., Saginaw, Mich.; a bearing bronze of copper 70, lead 30; impurities less than .2 of 1; resists corrosion caused by acids; resists heat to 500 degrees Fahr.; ductility medium; especially adapted for diesel engine bearings and airplane bearings.

See advertisement, Page 2-D

1 - - 4 5 - - - 9 -

ALCOA—Aluminum Co. of America, Pittsburgh. Aluminum wrought and casting alloys in following grades:

1 - - - 5 - - - 9 -

Grade 3S-¼H; manganese 1.25, balance aluminum plus normal impurities; finished rods or bars, tubing, wire, sheets, strips and plates, for stamping, extruding, welding, spinning, riveting, drawing, etc. Resists corrosion caused by all atmospheres, sea water, numerous chemicals; melts at about 1200 Fahr.; tensile strength, ult., 17,000 lbs. per sq. in. min.; ductility, high; bearing properties, fair; nonmagnetic; weldability, good. Used for low-stressed parts where high workability and resistance to corrosion are required.

Grade 3S; also available in tempers soft to hard, tensile strength ult. (min.) 14,000-27,000 lbs. per sq. in.; ductility decreases with increased tensile strength.

1 - - - - - - - 9 -

Grade 4S-½H; manganese 1.25, magnesium 1, balance aluminum plus normal impurities; sheets and plates, for stamping, welding, riveting, boring, etc. Resists corrosion caused by most atmospheres, food and petroleum products; tensile strength, ult., 32,000 lbs. per sq. in. min.; medium ductility; fair bearing properties; nonmagnetic. Used where moderately high strength, good corrosion resistance and bearing properties are required.

Grade 4S; also available in tempers soft to hard, tensile strength ult. (min.) 24,000-38,000 lbs. per sq. in.; ductility decreases as tensile strength increases.

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Grade 11S-T3; copper 5.5, lead .5, bismuth .5, balance aluminum plus usual impurities; finished rods or bars, wire and forgings, for turning, boring, etc. Resists corrosion caused by mild industrial atmospheres; not recommended for use above 250 Fahr. Tensile strength, ult., 45,000 lbs. per sq. in. min.; medium ductility; fair bearing properties; nonmagnetic; specific gravity 2.82. A free-machining alloy for automatic screw machine work where moderately high strengths and fair resistance to corrosion are required.

1 - - 4 - - - - 9 -

Grade 17S-T; copper 4, manganese .5, magnesium .5, balance aluminum plus usual impurities; finished rods or bars, tubing, wire, strips, plates, forgings, extruded and rolled shapes, for stamping, turning, riveting, hot forging, etc. Resists corrosion caused by industrial atmospheres; not recommended for use above 250 Fahr. Abrasion resistance, medium; tensile strength, ult., 55,000-58,000 lbs. per sq. in. min.; medium ductility; specific gravity 2.79; fair bearing properties; nonmagnetic. Used where high strength, moderately high resistance to corrosion and fair machinability are required.

1 - - - - - - - 9 -

Grade 52S-½H; magnesium 2.5, chromium .25, balance aluminum and usual impurities; finished rods or bars, tubing, wire, sheets, strips and plates, for stamping, welding, riveting, turning, etc. Resists corrosion caused by all atmospheres; melts at about 1200 Fahr., softens at 650 Fahr.; tensile strength, ult., 34,000 lbs. per sq. in. min.; medium abrasion resistance and ductility; specific gravity 2.67; fair bearing properties; weldability, fair; nonmagnetic. Used for parts in which high resistance to corrosion combined with moderate strength is required.

Grade 52S; also available in tempers from soft to hard, tensile strengths from 25,000-38,000 lbs. per sq. in.; ductility decreases as tensile strength increases.

Grade 53S-T; magnesium 1.3, silicon .7, chromium .25, balance aluminum plus usual impurities; finished rods or bars, tubing, wire, sheets, strips, plates, forgings and rolled and extruded shapes, for stamping, hot forging, welding, riveting, turning, etc. Resists corrosion caused by all atmospheres; softens at 400-650 Fahr.; tensile strength, ult., 32,000-35,000 lbs. per sq. in. min.; ductility, medium; specific gravity 2.69; bearing properties, fair; nonmagnetic. Used where high resistance to corrosion and moderately high strength and workability are required.

Grade 61S-T; magnesium .95, silicon .55, copper .25, chromium .25, balance aluminum plus usual impurities; tubing, sheets, plates and extrusions, for stamping, turning, boring, welding, riveting, spinning, drawing, etc. Corrosion resistant; softens at 650 Fahr.; medium abrasion resistant; tensile strength, ult., 43,000 lbs. per sq. in. min.; specific gravity 2.7; nonmagnetic. Used where moderate strength, good workability (forming) and fair machinability are required.

1 - - 4 - - - - 9 -

Grade 13; silicon 12, balance aluminum; furnished as die castings; resists corrosion caused by industrial and sea coast atmosphere; medium abrasion resistance; tensile strength, ult., 33,000 lbs. per sq. in.; specific gravity 2.66; fair bearing properties; nonmagnetic; weldability, good. For control and instrument cases, small frames and housings, nameplates, covers, conveyor links, etc.

Grade 43 (also known as Lynite 43); silicon 5, balance aluminum; furnished as castings; resists corrosion caused by industrial and sea coast atmosphere; medium abrasion resistance; minimum tensile strength, ult., 17,000 lbs. per sq. in. for sand castings, and 21,000 lbs. per sq. in. for permanent

1—*Corrosion resistant;* **2**—*Heat resistant;* **3**—*Abrasion resistant;* **4**—*High tensile strength;* **5**—*High ductility;* **6**—*Bearing application;* **7**—*Electrical uses;* **8**—*Heat treating;* **9**—*Low specific gravity;* **10**—*Machinability*

mold castings; medium ductility; specific gravity 2.67; nonmagnetic; brinell hardness, untreated, 40. Used for control and instrument cases, nameplates, covers, splash guards, housings, etc.

Grades 112 and 113 (also known as Lynite 112 and 113); copper 7.5, iron 1.2, silicon 4 max., zinc 2 max., balance aluminum; furnished as castings—No. 112 for sand casting and No. 113 for permanent mold castings. Resist corrosion caused by industrial atmospheres; medium abrasion resistance; tensile strength, ult., 19,000 lbs. per sq. in., min., for sand castings and 24,000 lbs. per sq. in., min., for permanent mold castings; compressive strength, ult., 62,000 and 70,000 lbs. per sq. in., respectively; specific gravity 2.86; fair bearing properties; nonmagnetic; brinell hardness 70-80 untreated. Used for gear cases, covers, bases, handwheels, small housings and other parts not subject to high stresses or impact.

1 - - 4 - - - - 9 -

Grades 195 and B195 (also known as Lynite 195 and B195). No. 195: copper 4, balance aluminum; No. B195: copper 4.5, silicon 3, balance aluminum. Both grades furnished as castings: No. 195 for sand casting and No. B195 for permanent mold castings; corrosion resistant; medium abrasion resistance; tensile strength, ult., 29,000-36,000 lbs. per sq. in. for sand casting and 32,000-35,000 lbs. per sq. in. min., for permanent mold casting; compressive strength, ult., 77,000-85,000 lbs. per sq. in.; high ductility; specific gravity 2.77; bearing properties, fair; nonmagnetic; brinell hardness, heat-treated, 65-95. Used for turrets, shaper rams and links, boring machine heads, planer tables, head and tail stocks, control levers, etc.

Grade 356 (also known as Lynite 356); silicon 7, magnesium .3, balance, aluminum; furnished as castings; corrosion resistant; medium abrasion resistance; tensile strength, ult., 27,000-30,000 lbs. per sq. in., for sand castings; 28,000-32,000 lbs. per sq. in., min., for permanent mold castings; compressive strength, ult., 80,000-87,000 lbs. per sq. in.; medium ductility; specific gravity 2.65; bearing properties, fair; nonmagnetic; brinell hardness, heat treated, 55-85. Used for pneumatic and hydraulic cylinders for presses, chucks and other intricate castings.

Grade 14S (also known as Lynite 14S); copper 4.4, silicon .8, manganese .8, magnesium .4, balance aluminum; furnished as forgings; corrosion resistant; medium abrasion resistance; tensile strength, ult., 65,000 lbs. per sq. in., min.; compressive strength, ult., 65,000 lbs. per sq. in.; ductility, medium; specific gravity 2.8; nonmagnetic; brinell hardness, heat treated, 130 min. Used for connecting rods and reciprocating linkage, ball cranks, hand levers, and other parts where maximum strength is required.

Grade A 51S (also known as Lynite A 51S); silicon 1, magnesium .6, chromium .25, balance aluminum; furnished as forgings; corrosion resistant; medium abrasion resistance; tensile strength, ult., 44,000 lbs. per sq. in., min.; specific gravity 2.69; nonmagnetic; weldability, good; brinell hardness, heat treated, 90 min. Used for control levers, bell cranks, reciprocating linkage, pneumatic cylinders and pistons, small gears, etc.

Lynite: Aluminum wrought and casting alloys in the following grades: No. 43, 112, 113, 195, B195, 356, 14S, and A51S. This material is also designated by the tradename Alcoa, and the foregoing grades are described in full under that tradename.

See advertisement, Page 13-D

1 - - - - - - 7 - - - -

ALCUMITE—Duriron Co. Inc., Dayton, O. Copper 90, aluminum 9, iron 1; for pumps, valves, pipe, fittings, bars and castings for corrosive service where a copper base alloy is preferred.

- - - - - - 7 - - - -

ALLEGHENY LUDLUM — Allegheny-Ludlum Steel Corp., Pittsburgh.

"4750"; furnished in rods, sheets, coiled strips and laminations for stamping, forming and drawing. Nickel 47 to 50, balance iron. Has very high permeability when dry hydrogen-annealed after fabrication; recommended heat treatments, 1800 to 2000 degrees Fahr. in dry hydrogen; used in audio transformers, sensitive relays and electrical instruments.

"88"; furnished in rods, sheets and plates for stamping, boring and welding. Nickel, 12 to 14; manganese, 5 to 7; balance, iron. Is nonmagnetic whether hard-worked or soft-annealed. Weldability, fair; recommended heat treatment, 1400 to 1475 degrees Fahr. Used where strength is required combined with nonmagnetic properties.

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Electrical steels furnished in sheets and coiled strips for stamping; ½ to 4½ per cent silicon according to requirements. Has magnetic and electrical properties, high permeability; high electrical resistance; nonaging; good surface insulation; fair weldability; recommended heat treatment, 1400 to 1450 degrees Fahr.; used for motor laminations.

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Relay steels furnished in rods or bars for turning, boring, etc.; 1 to 2½ per cent silicon. Has magnetic properties, high permeability; nonaging; electrical properties; low retentivity, low coercive force; weldability fair; recommended heat treatment, 1500 to 1550 degrees Fahr.; used for magnetic relays and solenoids.

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ALLEGHENY METAL—Allegheny-Ludlum Steel Corp., Pittsburgh.

18-8-S; stainless type 304; carbon .08 max., manganese .50 max., phosphorus .025 max., sulphur .025 max., silicon .50 max., chromium 17.5 to 19 and nickel 8 to 9.

19-9; stainless type 305; carbon .08 to .20, manganese .50 max., phosphorus .025 max., sulphur .025 max., silicon .50 max., chromium 18 to 20 and nickel 9 to 10.

19-9-S; stainless type 306; carbon .08 max., manganese .50 max., phosphorus .025 max., sulphur .025 max., silicon .50 max., chromium 18 to 20 and nickel 9 to 10.

18-8; stainless type 302; carbon over .08 to .20, manganese .50 max., phosphorus .025 max., sulphur .025 max., silicon .50 max., chromium 17.5 to 19 and nickel 8 to 9.

18-8EZ, (free-machining quality); stainless type 303; carbon .08 to .20, manganese .20 to 1.20, phosphorus .17 max., sulphur .60 max., silicon .70 max., chromium 17.5 to 19 and nickel 8 to 9.

20-10; stainless type 307; carbon .08 to .20; manganese .50 max., phosphorus .025 max., sulphur .025 max., silicon .50 max., chromium 20 to 22, and nickel 10 to 12.

20-10-S; stainless type 308; carbon .08 max., manganese .50 max., phosphorus .025 max., sulphur .025 max., silicon .50 max., chromium 20 to 22 and nickel 10 to 12.

Where fabrication requires deep drawing, welding or severe cold work, Allegheny Metal 19-9 will be found superior in most cases to Allegheny Metal 18-8-S because it has less tendency to work harden and requires much more cold work to make it magnetic. Its combined chromium and nickel insures greater stability than that of Allegheny Metal 18-8-S after short time heating such as in the welding operation. The higher carbon content also produces an alloy with higher true proportional limit and tensile strength giving greater resistance to reverse bending stresses thereby reducing the tendency for fatigue failure.

When special conditions of service justify the use of Allegheny Metal with additions of columbium, molybdenum, titanium, vanadium, or other elements, such modifications will be made.

Foregoing metals used for food, dairy, chemical and household equipment, and for railroad and automotive industries.

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18-8; carbon .08 to .20, phosphorus .025 max., sulphur .025 max., silicon .50 max., manganese .50 max., chromium 17.5 to 19, nickel 8 to 9; used for dairy and food processing equipment, automobile trim, chemical plant, household and kitchen accessories.

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Stainless 12 type 410; ("to be heat treated to specific physical properties"); also available in Stainless 12-TB type 403 (turbine quality), 12-NH type 405 (nonhardening quality), Stainless 12-EZ type 416 (free machining), and Stainless 12-W type 418. Carbon .12 max., manganese .50 max., phosphorus .025 max., sulphur .025 max., silicon .50 max., chromium 10 to 13.5; resists temperatures up to 1500 degrees Fahr.; used for automotive parts, combustion and steam engine parts, chemical plant equipment tanks, fans, blowers and furnace parts.

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Stainless 28 type 446; carbon .25 max., manganese 1.00 max., phosphorus .025 max., sulphur .025 max., silicon .50 max., chromium 23 to 30; for high temperature service up to 2150 degrees Fahr., used for furnace parts, boiler baffles, kiln lining, pyrometer protection tube, glass molds, oil still tube supports, etc.

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Stainless 17 type 430; also available in modified form in Stainless 17W type 438, containing tungsten, Stainless 21 type 442, containing 18 to 23 chrome. Carbon max. .12, manganese max. .50, phosphorus max. .025, sulphur max. .025, silicon max. .50, chromium 14 to 18; resists oxidation to temperatures up to 1600 degrees Fahr.; used for steel engine parts, low temperature furnace parts, fans and blowers, evaporators and chemical plant equipment.

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25-12 type 309; carbon .20 max., manganese 1.25 max., phosphorus .025 max., sulphur .025 max., silicon .50 max., chromium 22 to 26, nickel 12 to 14; resists scaling at temperatures up to 2000 degrees Fahr.; malleable and ductile; used for furnace parts, industrial ovens, kiln linings, still tube supports and pump parts.

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Grade 46 types 501 and 502; carbon .10 max., manganese .50 max., phosphorus .04 max., sulphur .04 max., silicon .50 max., chromium 4 to 6; following elements may be added for increased resistance to oxidation and/or improved mechanical properties; Molybdenum .40 to .60, tungsten .75 to 1.25, copper 0.5 to 1; for nonhardening characteristics aluminum .10 to .25, titanium or columbium ten times carbon per cent; adaptable for wide range of uses in the oil industry.

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ALNICO—General Electric Co., Schenectady, N. Y. Permanent magnet alloy of high coercive force; nickel 20 to 30 per cent, aluminum 10 to 12, cobalt 3 to 5, balance iron; extremely hard and obtainable in cast form. Licensees include: Arnold Engineering Co., Chicago; Belden Mfg. Co., Chicago; Cinaudagraph Corp., Stamford, Conn.; Crucible Steel Co. of America; New York; General Magnetic Corp., Chicago; Indiana Steel Products Co., Chicago; Simonds Saw & Steel Co., Lockport, N. Y.; Taylor-Wharton Iron & Steel Co., High Bridge, N. J.; and Thomas and Skinner Steel Products Co., Indianapolis.

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ALUMINWELD—Lincoln Electric Co., Cleveland. A 5 per cent silicon-aluminum-alloy electrode for arc welding aluminum in any form—cast, sheet, shapes, or extruded forms. For either metallic or carbon arc welding. Welds are very dense without porosity and possess high tensile strength.

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AMBRAC—American Brass Co., Waterbury, Conn. Grade A; copper 75, zinc 5, nickel 20; high ductility; used for condenser tubes, etc.

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AMBRALOY—American Brass Co., Waterbury, Conn. Aluminum brass alloys for varied special uses, particularly condenser tubes.

AMERICAN—American Nickeloid Co., Peru, Ill.

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Bonded metals; chromium, nickel, brass, copper, gold resemblance and colors bonded to base metals such as steel, tin-plate, zinc, brass, copper, aluminum and nickel silver. Available in brilliant finishes and patterns as sheets, flat strips, coiled strip and round edge flat wire. Can be supplied with gum adhered paper covering protecting prefinish in drawing and forming. For parts and trim of coin-operated phonographs, vending and game machines, toys, dispensers, hardware specialties, stoves, refrigerators, automobiles, radios, washing machines, etc.

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Nickel Aluminum; nickel bonded to aluminum; rustproof, lightweight; highly corrosion resistant white metal base. Available in variety of brilliant finishes and patterns as sheets and flat strips; can be supplied with quick-removable adhered paper covering permitting drawing and forming without marring prefinish. For electrical appliances, moldings, nameplates, etc.

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Chrome Aluminum; chromium bonded to aluminum, rustproof; lightweight; highly corrosion resistant white metal base; available in variety of brilliant finishes and patterns as sheets and flat strips; furnished with quick removable gum-adhered paper covering permitting drawing and forming without marring prefinish. For uses same as Nickel Aluminum.

1—*Corrosion resistant;* **2**—*Heat resistant;* **3**—*Abrasion resistant;* **4**—*High tensile strength;* **5**—*High ductility;* **6**—*Bearing application;* **7**—*Electrical uses;* **8**—*Heat treating;* **9**—*Low specific gravity;* **10**—*Machinability*

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AMERICAN QUALITY—American Steel & Wire Co., Cleveland. Carbon steels and alloys in the form of cold-rolled strip, manufacturer's wire and springs.

See advertisement, Page 17-D

1 - 3 4 5 6 - - - -

AMPCO METAL—Ampco Metal Inc., Milwaukee. Special copper-base alloys for wear and corrosion-resistant service; produced in seven grades.

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Grade 12; copper 88.2, aluminum 8.6, iron 2.9, others .3; furnished in rods, bars, sheets, and plates, for hot forging, turning, boring and welding; also as sand or centrifugal castings; corrosion resistant; resists heat to 1000 degrees Fahr.; low abrasion resistance; tensile strength 65,000 lbs. per sq. in.; compressive strength 120,000 lbs. per sq. in.; high ductility; specific gravity 7.735; good bearing properties; nonmagnetic; brinell hardness 115; for use as bushings and bearings.

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Grade 16; copper 86.2, aluminum 10.2, iron 3.3, others 0.3; furnished in rods, bars, sheets and plates for hot forging, turning, boring and welding; also as sand or centrifugal castings; corrosion resistant; resists heat to 1000 degrees Fahr.; medium abrasion resistance; tensile strength, 75,000 lbs. per sq. in.; compressive strength, 125,000 lbs. per sq. in.; high ductility; specific gravity 7.628; good bearing properties; nonmagnetic; fair weldability; brinell hardness, heat treated, 137; used for bearings, gears, worm-wheels, liners, lead screw nuts—all for heavy duty where exceptional resistance to wear is required.

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Grade 18; copper 84.6, aluminum 11.3, iron 3.2, others 0.4; furnished in rods, bars, sheets and plates, for hot forging, turning, boring and welding; also as sand or centrifugal castings; corrosion resistant; resists heat to 1000 degrees Fahr.; tensile strength 80,000 to 85,000 lbs. per sq. in.; compressive strength 136,000 lbs. per sq. in.; medium ductility; good bearing properties; nonmagnetic; brinell hardness, heat treated, 173; for use as heavy-duty, wear-resistant gears, worm-wheels, feed nuts, bearings, welding bases and pickling equipment.

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Grade 18-23; aluminum 10.6-11.2, iron 3.4-4, others .4 max., copper balance; furnished in rough bars or billets and as sand casting for hot forging; resists heat to 750 degrees Fahr.; high abrasion resistance; tensile strength 95-105,000 lbs. per sq. in.; good bearing properties; weldability good; used for parts requiring high strength, good bearing and wearing resistance.

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Grade 20; copper 83.13, aluminum 12.40, iron 4.07, and others 0.4; available as sand and centrifugal castings; corrosion resistant; resists heat to 1000 degrees Fahr.; high abrasion resistance; tensile strength 85,000 lbs. per sq. in.; compressive strength 146,000 lbs. per sq. in.; specific gravity 7.437; good bearing properties; nonmagnetic; brinell hardness, untreated, 241; for use as cams and cam rollers, welding jaws, bushings, bearings, and other wear resistant parts.

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Grade 21; copper 82.34, aluminum 13.02, iron 4.14, others 0.5; available as sand and centrifugal castings; resists heat to 1000 degrees Fahr.; high abrasion resistance; tensile strength, ult., 90,000 lbs. per sq. in.; compressive strength, ult., 160,000 lbs. per sq. in.; ductility, low; specific gravity, 7.152; fair bearing properties; nonmagnetic, brinell hardness, untreated, 311; for use as forming and drawing dies, bushings and bearings replacing hardened steel.

- - 3 4 - 6 - - - -

Grade 22; copper 81.67, aluminum 13.42, iron 4.41, others .50; available as sand and centrifugal castings; resists heat to 1000 degrees Fahr.; high abrasion resistance; tensile strength 90,000 lbs. per sq. in.; compressive strength 171,000 lbs. per sq. in.; low ductility; specific gravity 7.125; fair bearing properties; nonmagnetic; brinell hardness, untreated, 335; for use as forming and drawing dies.

See advertisement, Page 3-D

1 - - 4 5 6 - - - -

AMPCOLOY—Ampco Metal Inc., Milwaukee. Various grades of copper-base alloys.

1 - - 4 5 - - - - -

Grade E-1; copper 89, aluminum 10, iron 1; furnished in rough bars or billets, rods or bars, for sand casting, hot forging, extruding, turning, boring, and as centrifugal castings. Resists corrosion caused by acids and other corrosives; resists heat to 1000 degrees Fahr.; medium abrasion resistant; tensile strength, ult., 70,000 to 80,000 lbs. per sq. in.; compressive strength, ult., 136,000 lbs. per sq. in.; ductility, high; specific gravity, 7.48; bearing properties, good; nonmagnetic; used for gears, pickling equipment, bearings, screw down nuts.

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Grade E-123; same analysis as E-1; furnished in rough bars or billets and finished rods and bars, for sand casting, hot forging, turning, boring, and as centrifugal castings. Resists heat to 1000 degrees Fahr.; medium abrasion resistant; tensile strength, ult., 90,000 lbs. per sq. in.; compressive strength, ult., 145,000 lbs. per sq. in.; ductility, medium; specific gravity, 7.48; bearing properties, good; nonmagnetic; weldability, fair; used for gears, worm wheels, feed nuts and bearings.

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Grade A-3; same analysis as E-1; furnished in rough bars or billets, finished rods or bars and plates, for sand casting, hot forging, turning, boring, and as centrifugal castings. Resists corrosion caused by acids and other corrosives; resists heat to 1000 degrees Fahr.; medium abrasion resistant; tensile strength, 75,000 lbs. per sq. in.; compressive strength, ult., 135,000 lbs. per sq. in.; ductility, high; bearing properties, good; nonmagnetic; weldability. good; brinell hardness, untreated, 120; for gears, forgings, bushings, bearings, and pressure parts. Heat treated will meet Fed. Spec. QQ-B-671 Grade B.

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Grade A-323; same analysis as E-1; furnished in rough bars or billets, finished rods or bars and plates, for sand casting, hot forging, turning, boring, and as centrifugal castings. Resists corrosion caused by mild corrosives; resists heat to 1000 degrees Fahr.; medium abrasion resistant; tensile strength, ult., 85,000 lbs. per sq. in.; compressive strength ult., 136,000 lbs. per sq. in.; ductility, high; specific gravity, 7; bearing properties, good; nonmagnetic; weldability, good; used for gears, bushings, bearings, sleeves and forks.

See advertisement, Page 3-D

1 2 3 4 5 - - 8 - -

AMSCO—American Manganese Steel Div., The American Brake Shoe & Foundry Co., Chicago Heights, Ill.

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Manganese steel; 10 to 14 manganese, 1 to 1.40 carbon, balance iron; suitable for sand casting; for power shovel dippers and teeth, rock crusher parts, dredge pumps, etc.

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Alloy F-1; 15 to 17 chromium, 34 to 36 nickel; for conveyor chain, enameling furnace supports, burner parts etc.; heat resistant to 2100 degrees Fahr.; creep resistant at high temperatures.

F-3; 27 to 29 chromium, 0 to 3 nickel; for rabble arms and blades, sintering bars, etc.; heat resistant to 1800 degrees Fahr. where temperature changes are not wide and where high unit strength is not essential.

F-5; 17 to 19 chromium, 65 to 68 nickel; furnace conveyor pans, heat treating boxes, enameling fixtures, etc.; similar properties to F-1 and F-6, except tougher and more resistant to temperature fluctuations.

F-6; 12 to 14 chromium, 59 to 62 nickel; for heat treating boxes, retorts, etc.

F-8; 20 to 22 chromium, 8 to 10 nickel; for mine water and acid pump parts, marine fittings, chemical mixer and paper mill digester parts.

F-10; 26 to 28 chromium, 10 to 12 nickel; for heat treating furnace shafts, dampers and valves, cement kiln cooler parts, etc.; creep resistant at high temperatures.

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Nickel-manganese steel; 13 to 15 manganese, .70 to .90 carbon, .95 to 1.20 silicon, 3.50 to 4.50 nickel; welding rod for building up austenitic manganese steel castings.

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No. 459; chromium molybdenum hard alloy welding rod for hard surfacing machinery wearing parts; deposits are 500 to 600 brinell.

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No. 217; chromium-molybdenum-tungsten welding rod for hard facing cast wearing parts; extreme hardness and great wear resistance.

- 2 3 - - - - - - -

Dieweld; a chromium-molybdenum welding rod for building up forming dies, cutting tools, punches, shear knives, etc.

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Economy hardface; self-hardening, chromium-molybdenum-high carbon welding rod manufactured bare for oxy-acetylene deposition; used for applications where extreme impact and abrasion are encountered.

See advertisement, Page 67-D

1 2 3 4 5 6 7 8 - 10

ANACONDA—American Brass Co., Waterbury, Conn. Many grades of this alloy, as well as pure copper in various forms under this tradename are available, some of which are listed below.

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Beryllium Copper; copper 97.75, beryllium 2.25, nickel 0.25; abrasion resistant; high tensile strength and ductility; for springs, diaphragms, low duty bushings and bearings.

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"85" Red Brass; copper 85, zinc 15; pipe tube and sheet forms; particularly resistant to salt water corrosion.

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Super-Nickel; copper 70, nickel 30; seamless tubes, sheets and plates; for severe condenser tube service and resistance to salt water corrosion.

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Special Phosphor Bronze; copper 88, tin 4, zinc 4, lead 4; corrosion, heat and abrasion resistant; combines general characteristics of standard phosphor bronze alloys with free cutting qualities of yellow brass.

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ANFRILOY—Wellman Bronze & Aluminum Co., Cleveland. A copper-lead-tin bearing bronze for high speed, light-duty bearings and for bushings where pressure and thrust are not excessive.

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ANTIMONIAL ADMIRALTY—Chase Brass & Copper Co., Waterbury, Conn. Copper 71, tin 1, antimony .07, zinc 27.93. Outstanding for general corrosion resistance and particularly for preventing dezincification. Recommended for condensers in the power plant and oil industries.

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APOLLOY METAL—Apollo Steel Co., Apollo, Pa. Carbon .06-10, manganese .30-60, sulphur .045 max., phosphorus .04 max., copper .20 per cent min.; in sheets.

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ARISTOLOY—Copperweld Steel Co., Glassport, Pa. Full range of S.A.E. alloy steels, also aircraft, and special steels; used for gears, both light and heavy-duty, clutches, shafts and pinions; also in ball and roller bearings and aircraft parts, both for engine and plane use.

1 2 3 4 5 - 7 - - -

ARMCO—American Rolling Mill Co., Middletown, O.

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Stainless steel, grade 18-8 (type 302, 304); 17-7 (type 301); 18-12 Mo. (type 316); 25-12 (type 309); 17 (type 430); 13 (type 410); 19-12 Mo. (type 317); 18-10 Cb. (type 347); and 27 (type 446); these can all be drawn and stamped; all machinable, abrasion resistant and weldable.

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Armco High Tensile; low carbon-nickel-phosphorus steel containing molybdenum. Supplied in sheets, strips and plates; suitable for stamping and welding.

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Tran-Cor 58; high silicon steel for distribution transformers. Grade 65; steel sheets with low core loss, for power and distribution transformers. Grade 72; a high silicon steel for large generators and general transformer work.

1—*Corrosion resistant;* 2—*Heat resistant;* 3—*Abrasion resistant;* 4—*High tensile strength;* 5—*High ductility;* 6—*Bearing application;* 7—*Electrical uses;* 8—*Heat treating;* 9—*Low specific gravity;* 10—*Machinability*

Intermediate Transformer; scale-free silicon steel sheet for some transformer and special applications.

Special Electric; scale-free medium steel sheet for a.c. motors and generators.

Electric; special analysis sheet for rotating machines.

Armature; steel sheet for small d.c. motors.

Field Grade; special sheet for intermittent duty fractional horsepower motors.

Radio No. 6; for applications in which superior low induction magnetic characteristics are important. No. 5; for audio transformer cores and other low induction applications. No. 4; good permeability at low induction; for chokes. Nos. 3, 2 and 1; for small transformers.

Ingot Iron; highly refined iron for magnetic cores; supplied in round and flat bar form.

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Armco Ingot Iron; highly refined iron supplied in galvanized sheet for general sheet metal work; also hot rolled annealed and cold rolled sheets, plates and strip.

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Armco Enameling Iron; highly refined iron for enameling purposes; supplied in sheets.

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ASARCOLOY No. 7—American Smelting & Refining Co., New York. A cadmium-nickel bearing alloy capable of withstanding high compression loads and high operating temperatures. Nickel 1.3, balance cadmium. Furnished in ingots for spinning and permanent mold castings. Resists heat to 300 degrees Fahr.; high abrasion resistance; tensile strength, ult., 15,000 lbs. per sq. in.; compressive strength, ult., 20,000 lbs. per sq. in.; specific gravity, 8.7; bearing properties, good; weldability, good; brinell hardness, untreated 33; used for bearings.

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ATLAS No. 93—Allegheny-Ludlum Steel Corp., Pittsburgh Carbon, 55, chromium .65, molybdenum .35; for collets, studs and parts requiring toughness in hardened condition. Oil hardening.

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AUROMET—Aurora Metal Co., Aurora, Ill. Special aluminum and silicon bronzes of several compositions.

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AVIALITE—American Brass Co., Waterbury, Conn. Copper-aluminum alloy for valve seats and guides in airplane motors.

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"AW" (rolled steel floor plate)—Alan Wood Steel Co., Conshohocken, Pa. Furnished in five patterns to meet flooring problems in the industrial and transportation fields; designed to withstand heaviest traffic; oilproof, crackproof, heatproof, slipproof, and noiseless. Furnished in carbon, copper or alloy analysis; also available in other nonferrous metals.

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"AW" DYN-EL—Alan Wood Steel Co., Conshohocken, Pa. Furnished in sheets, strips, and plates, for stamping, welding, cold forming and hot forming, etc.; abrasion resistance medium; tensile strength 70,000-80,000 lbs. per sq. in.; ductility high; weldability good; fatigue and impact values high; for structures requiring high strength.

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B & W CROLOY—Babcock & Wilcox Tube Co., Beaver Falls, Pa.

2; carbon .15 max., chromium 1.75-2.25, molybdenum .45-.65, silicon .50 max.; for refinery and superheater tubes. Corrosion resistant and heat resistant at nominal temperatures.

3¼; carbon .15 max., chromium 2-2.5, molybdenum .9-1.1, silicon .5 max.; for refinery and superheater tubes where exceptionally high creep strength is required.

5; chromium molybdenum; carbon .15 and .2 max., chromium 4-6, molybdenum .45-.65; for oil refinery service.

7; carbon .15 max., chromium 6-8, molybdenum .45-.65 for oil refinery service where increased corrosion resistance is required.

9; carbon .15 max., chromium 8-10, molybdenum 1.2 min.; semistainless alloy of good physical properties and corrosion resistance.

12 (type 410); carbon .15 max., chromium 12-14; resistant to atmosphere and acids; resists heat to 1500 degrees Fahr. and when heat treated has tensile strength of 180,000 lbs. per sq. in.

18 (type 430); carbon .12 max., chromium 15-18; useful for certain elevated temperature applications but particularly for nitric acid plant equipment.

18-8S (type 304); carbon .08 max., chromium 18-20, nickel 8-11; low carbon; for high temperature work or corrosion resistant service.

16-13-3 (type 316); carbon .10 max., manganese 2 max., chromium 16-18, nickel 11-14; molybdenum 2-3; austenitic type alloy similar in many respects to 18-8s and 25-20; high strength at elevated temperatures; corrosion resistant.

25-20 (type 310); chromium 25, nickel 20; high strength and high oxidation resistance; also excellent corrosion resistance.

27 (type 446); carbon .2 max., chromium 26-30, resistant to oxidation to 2100 degrees Fahr.; also corrosion resistant.

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BAKER—Baker & Co. Inc., Newark, N. J. Platinum and alloys for linings, contacts, thermocouples, furnace resistors, etc.

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BEARITE—A. W. Cadman Mfg. Co., Pittsburgh; babbitt metal furnished in ingots and 50-pound pigs; brinell hardness at 70 degrees Fahr. 29.1, 212 degrees Fahr. 24.4; compressive strength 15,000 lbs. per sq. in.; for rotary bearings subjected to heavy loads and extreme speed.

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BECKETT METAL—Beckett Bronze Co., Muncie, Ind. Several grades of high lead bronze; copper 60 to 75, tin 3 to 9, lead 16 to 35, and nickel 0 to 1; furnished in rough bars and rods (cored or solid) for turning, boring, etc.; resists corrosion due to sulphuric-hydrochloric acid solutions, and resistant to heat to 400 deg. Fahr.; tensile strength 21,000 to 24,000 lbs. per sq. in.; good bearing properties; brinell hardness, untreated, 36 to 46; used for bearings, bushings, and to a limited extent in seals, piston rings and gears.

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BELECTRIC—Belle City Malleable Iron Co., Racine, Wis. Furnished as sand castings; tensile strength 35,000-60,000 lbs. per sq. in.; high compressive strength; good bearing properties; recommended heat treatments are the same as for standard gray iron; brinell hardness, untreated 179-285, heat treated 300-550; used where rigidity, wearability or where strong high grade gray iron might be applied.

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BELECTROMAL—Belle City Malleable Iron Co., Racine, Wis. High strength malleable iron furnished as sand castings; tensile strength 60,000-70,000 lbs. per sq. in.; high ductility; brinell hardness, untreated 140-170; recommended for castings for automotive, railroad tractor and implement work.

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BELMALLOY—Belle City Malleable Iron Co., Racine, Wis. Pearlitic malleable iron, electric furnace melted and continuous oven annealed: for castings of machining quality requiring strength and shock resistance.

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BERMAX—Federal Mogul Corp., Detroit. A high lead babbitt; easy to use, cast and easy to handle in rebabbitting; melting point slightly higher than that of tin-base metals and can be cast by any method without fear of segregation; for use as bearing lining.

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BETHADUR—Bethlehem Steel Co., Bethlehem, Pa. Steels of the designated characteristics for virtually all purposes except those calling for free machining. This tradename covers 43 different corrosion resistant alloying steels adaptable for machinery in the chemical industries, oil refining, mining and metallurgy, the paper industry, the food industry, etc. The following are typical examples:

No. 302; 18-20 chromium, 8-10 nickel, .08-.20 carbon.

No. 304; 18-20 chromium, 8-10 nickel, .08 max. carbon.

No. 308; 19-22 chromium, 10-12 nickel, .08 max. carbon.

No. 403; 11.5-13 chromium, .15 max. carbon (turbine blading).

No. 410; 10-13.5 chromium, .15 max. carbon.

No. 420; 12-14 chromium, .15 min. carbon.

No. 430; 14-18 chromium, .12 max. carbon.

No. 440; 14-18 chromium, .12 min. carbon.

No. 442; 18-23 chromium, .35 max. carbon.

No. 446; 23-30 chromium, .35 max. carbon.

No. 501; 4-6 chromium, .10 min. carbon.

No. 502; 4-6 chromium, .10 max. carbon.

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BETHALON—Bethlehem Steel Co., Bethlehem, Pa. Free-machining, high chromium steel for variety of machine parts. Two typical grades are the following:

No. 303; 18-20 chromium, 8-10 nickel, .20 max. carbon, .15 min. or .60 max. sulphur or selenium.

No. 416; 12-14 chromium, .12 max. carbon, .15 min. or .60 max. sulphur or selenium.

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BETH-CU-LOY—Bethlehem Steel Co., Bethlehem, Pa. A copper bearing steel resistant to atmospheric corrosion; for jackets, covers, machine guards, oil pans, etc.

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BETHLEHEM—Bethlehem Steel Co., Bethlehem, Pa.

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Nos. 235 and 300; abrasion resistant, high-carbon-manganese-silicon steels of 235 and 300 brinell respectively; for shovels, crushers, hoppers, scraper blades and conveyors.

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Nos. 6 and 7; nickel steels containing 35 and 40 per cent nickel respectively; have low coefficient of expansion; for scientific and measuring instruments and for control equipment.

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BETHLEHEM—Bethlehem Steel Co., Bethlehem, Pa.

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Bearing steels; high carbon steels in three grades, namely; "Standard" chromium steel, "H. T. W." chromium-vanadium steel, and "Moly" chromium-molybdenum steel. All grades are processed to meet requirements of bearings for automotive and industrial service. Other uses include injector parts for diesel engines.

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Magnet steels; high carbon steels with varying chromium content, up to 6 per cent. Permanent magnet No. 1, a 6 per cent tungsten steel; Cobaflux, a high cobalt steel used for magnets in meters, telephones, magnetos and other electrical equipment.

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BETHLEHEM 88-80—Bethlehem Steel Co., Bethlehem, Pa. Chromium molybdenum steel castings with high abrasion resistance for ball mill liners, rolls, tires, bottom plates, etc.

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BIRDSBORO—Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.

No. 26; high physical properties including high tensile strength; resists corrosion because of copper content; for dredge castings and other castings subject to high stress.

No. 30; resists corrosion due to its copper and molybdenum content; recommended for dredge castings and other castings subject to high stress.

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BISHOP STAINLESS—J. Bishop & Co. Platinum Works, Malvern, Pa. A stainless steel seamless tubing; heat and corrosion resistant; furnished in a large number of diameter and gage combinations. Mechanical tubing class comprises large group of sizes and uses, from tiny tubing 1/100 in. outside diameter for fine instruments to ¾-inch, ⅞ or 1-inch sizes for condensers, dairy equipment, heat exchangers, chemical plant equipment etc. Capillary tubing has very small bore in relation to outside diameter, produced in long lengths and in a variety of sizes. Hypodermic needle tubing; available in range from 33 to 11 Stubbs gage having appropriate wall thickness and held within close tolerances.

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BLACKSKIN ADMIRALTY, Bulldog Brand—Phelps Dodge Copper Products Corp., New York. Copper 70, zinc 29, tin 1; furnished in tubing, sheets and strips for extruding, welding and drawing; corrosion resistant; resists heat to 450 degrees Fahr.; tensile strength 45,000-95,000 lbs. per sq. in.; high ductility; for condenser tubes.

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BOHNALITE—Bohn Aluminum & Brass Corp., Detroit. Light alloy of which aluminum is the base; for forged connecting rods, cast cylinder heads, crankcases, transmission cases, and parts for vacuum cleaners, washing machines, shoe machinery, etc.

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BORIUM—Stoody Co., Whittier, Calif. Tungsten carbide metal used chiefly as inserts in ro-

1—*Corrosion resistant;* **2**—*Heat resistant;* **3**—*Abrasion resistant;* **4**—*High tensile strength;* **5**—*High ductility;* **6**—*Bearing application;* **7**—*Electrical uses;* **8**—*Heat treating;* **9**—*Low specific gravity;* **10**—*Machinability*

tary drilling tools as substitute for diamonds. Tube Borium and Borod; made up of steel tubing containing fine particles of Borium; used as overlays on earth working equipment.

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BOUND BROOK—Bound Brook Oil-less Bearing Co., Bound Brook, N. J. Graphited bronze; bushings, bearings and washers; cast phosphor bronze inlaid with graphite, particularly adaptable to high temperatures, severe static loads, immersion in liquids, exposure to dusts or where oils are objectionable.

See advertisement, Page 59-D

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BRASSOID—American Nickeloid Co., Peru, Ill. Brass bonded to zinc, latter serving as rustproof, flexible and inexpensive white metal base. Available in variety of brilliant finishes and patterns, as sheets, flat strips and coiled strip for continuous feed automatic presses. Can be supplied with quick removable, gum adhered paper covering permitting drawing and forming without marring pre-finish. For toys, machinery trim and nameplates, index and instruction plates, etc.

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BRIDGEPORT COPPER AND ZINC ALLOYS—Bridgeport Brass Co., Bridgeport, Conn.

Yellow brass; copper 65, zinc, 35, copper 70, zinc 30; sheet, wire and seamless tubing for drawing, stampings, and cold heading.

Free cutting brass rod; copper 60, lead 3, balance zinc; for making automatic screw machine parts.

Low brass; copper 80, zinc 20; pale golden color; for articles requiring greater ductility and malleability than possessed by yellow brass.

Commercial bronze; copper 90, zinc 10; bronze color for manufacturing stampings and drawn items and cold headed items, for outdoor use; stands weathering better than yellow brass; copper sheet, rod, wire, seamless tubing for miscellaneous manufacturing. Leaded brass alloys, containing from 5 per cent to 5 per cent to facilitate machining.

Phosphor bronze; copper 92, tin 8; for spring parts; has better spring properties than 95 per cent and 5 per cent.

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Phosphor bronze; copper 95, tin 5; sheet spring quality for manufacturing switch parts.

Copper in form of sheet and tube for fabricating.

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BUFLOKAST—Buffalo Foundry & Machine Co., Buffalo. Silicon 1 to 2, sulphur .07-.12, phosphorus .10-.40, manganese .60-1.25, carbon 2.90-3.80, nickel .50-3, chromium .5-2, molybdenum .5-1.50; furnished as sand castings; resists corrosion due to acids and alkalies; resists heat to 1800 degrees Fahr.; medium abrasion resistance; tensile strength ult., 30,000-60,000 lbs. per sq. in.; for chemical and vacuum drying machinery.

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BUNTING—Bunting Brass & Bronze Co., Toledo. A line of some 160 bearing bronzes available as fully-machined bar stock and ready-cut bushings, including the following:

Alloy No. 27; phosphor bronze (leaded) for bearings.

Alloy No. 51; for low speeds, heavy loads, gears; free-machining.

Alloy No. 72; general purpose bearing bronze; used in standard stock items.

Alloy No. 96; high strength, excellent machinability, low speeds, heavy loads.

Alloy No. 124; camshaft bearings, piston pin bearings, etc.

Alloy No. 125; high lead, low friction, scanty lubrication applications.

Alloy No. 135; for average bushing applications.

Alloy No. 156; hard gear bronze.

Alloy No. 164; nickel gear bronze, synchronizer cones.

Alloy No. 178; copper-lead precision type main and connecting rod bearings. Genuine babbitt, tin base babbitt; high strength ingot material for bearings.

Babbitt; genuine babbitt, lead base babbitt.

Precision; cored and solid fully-machined bar stock from dense grained bearing bronze.

See advertisement, Page 18-D

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CANNON 3½ PER CENT NICKEL STEEL—Cannon-Stein Steel Corp., Syracuse, N. Y.

S.A.E. 2315; carbon .15, manganese .45, phosphorus .04, sulphur .05, silicon .30, nickel .35; brinell hardness untreated 174; recommended heat treatment carburized at 1650 degrees Fahr., heat treated at 1450-1500 degrees Fahr. oil quenched. Resists corrosion due to nickel content; resists heat to 800-1000 degrees Fahr.; tensile strength 85,000 lbs. per sq. in. as rolled; for king pins, rock drill parts, air hammer parts, universal joints, bolts, shafts, studs, etc.

S.A.E. 2320; carbon .20, manganese .50, phosphorus .04, sulphur .05, silicon .03 max., nickel 3.50; brinell hardness untreated 174; recommended heat treatment carburized at 1650 degrees Fahr., heat treated at 1450-1500 degrees Fahr.; resists corrosion due to nickel content; resists heat to 800-1000 degrees Fahr.; tensile strength 90,000 lbs. per sq. in. as rolled; for uses same as S.A.E. 2315.

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CANNONITE—Campbell, Wyant & Cannon Foundry Co., Muskegon Heights, Mich. Electric furnace high test cast iron; for diesel and auto cylinders, centrifugal sleeves and brake drums, gas-tight castings, presses, dies, etc.

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CARBOLOY—Carboloy Co. Inc., Detroit. A series of cemented carbides embodying tungsten carbide, tungsten and tantalum carbides, tungsten and titanium carbide or combinations of these. Has high resistance to abrasive and corrosive wear; outstanding on account of its extreme hardness, compressive strength being as high as 800,000 lbs. per sq. in.; Rockwell hardness on "A" scale 86-93; does not rust or corrode under normal conditions. Recommended as wear resistant inserts for machine parts subject to extreme wear such as cams, cam followers, hydraulic valve stems and seats, machine tool rests, etc.

See advertisement, Page 77-D

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CARBOMANG—Detroit Alloy Steel Co., Detroit. Furnished as castings. Carbon .90-1.00, manganese 1.00-1.10, chromium .40-.60; medium abrasion; tensile strength, ult., 125.000 lbs. per sq. in.; compressive strength, ult., 200,000 lbs. per sq. in.; medium ductility; brinell hardness, untreated 200, heat treated 600; for air-hardening tool steel castings.

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CARPENTER—The Carpenter Steel Co., Reading, Pa.

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Stainless No. 1 bar steel; carbon .1, chromium 12; for valve trim, turbine blades, heat-treated parts; also has high ductility.

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Stainless No. 2; carbon .3; chromium 13; used in fully hardened condition for ball bearings, ball check valves, cutlery, instruments, etc.

Stainless No. 2B; carbon 1, chromium 17; uses same as No. 2.

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Stainless No. 3; carbon .3, chromium 20, copper 1; for special chemical apparatus and scale resisting parts.

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Stainless No. 4; carbon .1, chromium 18, nickel 8; for rolled moldings, stampings, etc.; also has high ductility.

Stainless No. 5; carbon .1, chromium 14, sulphur .30; a free machining grade for automatic screw machine parts, valve trim, pump shafts, etc. Is heat resistant.

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Stainless No. 6; carbon .1, chromium 16 to 18; uses same as No. 1 and No. 4.

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Stainless No. 8; carbon .1, chromium 18, nickel 8, selenium .25; a free machining grade; heat resistant.

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Chrome magnet steel; carbon .95, chromium 3.5; for magnets in meters and other electrical apparatus.

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Presto; carbon 1.05, chromium 1.4; for ball and roller bearings.

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Silico-manganese steel; carbon .6, manganese .75, silicon 2; for heavy duty springs.

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No. 5-317; chrome nickel steel; carbon .5, nickel 1.75, chromium 1; for gears, clutches and shafts.

No. 5 Samson; carbon .5, nickel 1.25, chromium .6; for gears and clutches.

No. 4-408; carbon .4, nickel 3, chromium .75; for clutches and shafts.

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No. 158; carbon .1, nickel 3.5, chromium 1.5; for case hardened high duty clash gears, shafts, clutch parts.

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No. 4 Samson steel; carbon .4, nickel 1.25, chromium .6; for side links of silent chains, shafts, axles, etc.

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No. 2 Samson; carbon .2, nickel 1.25, chromium .6; for case-hardened gears, roller bearings, pneumatic tool parts, etc.

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No. 3-547; nickel steel; carbon .3, nickel 3.5; for heat treated shafts, etc.

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No. 2-547; case hardening nickel steel; carbon .2, nickel 3.5; for small parts requiring hard surface and tough core.

No. 500; carbon .1, nickel 5; for turbine blades, case-hardened gears, etc.

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Chrome vanadium 5-720; carbon 5, chromium .9, vanadium .2; for leaf and coil springs, gears, shafts, etc.

No. 3-427 chrome molybdenum steel; carbon .3, chromium 1, molybdenum .2; for aircraft and automotive parts.

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No. 436; carbon .15, nickel 1.75, molybdenum .25; for case-hardened parts.

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Temperature compensator alloy; iron-nickel alloy; furnished in rough bars or billets, finished rods or bars, wire and strips for hot forging, stamping, turning, boring, etc.; permeability varies inversely as temperature; for magnetic shunts for meters, speedometers, tachometers, voltage regulators, etc.

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CAST ALLOY STEEL—The Alloy Cast Steel Co., Marion, O.

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Nickel steel castings; carbon .30-.40, manganese .60-.80. sulphur .05 max., phosphorus .045 max., silicon .35-.45, nickel 3.25-3.75; has high strength and resistance to shock and fatigue; used largely in annealed condition, although responds to heat treatment.

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Nickel chrome steel castings; carbon .35-.45, manganese .60-.80, phosphorus .045 max., sulphur .05 max., silicon .35-.45, nickel 1.50-2.00, chromium .60-.75; has high strength and wear resistance.

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Nickel, chrome, molybdenum steel castings; carbon .35-.45, manganese .60-.80, phosphorus .045 max., sulphur .050 max., silicon .35-.45, nickel 1.50-2.00, chrome .60-.75, molybdenum .25-.45; used in parts which must be strong and hard and where size or shape prevent liquid quenching.

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Manganese molybdenum steel castings; carbon .30-.40, manganese 1.25-1.60, phosphorus .045 max., sulphur .050 max., silicon .35-.45, molybdenum .25-.45; used for gears, sprockets, levers, etc.

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Medium manganese steel castings; carbon .30-.40, manganese 1.25-1.50, phosphorus .045 max., sulphur .050 max., silicon .35-.45; used in power shovels, tractors, road machinery, etc.

High manganese steel castings; carbon 1.10-1.30, manganese 10.50-13.50, phosphorus .10 and under; tensile strength, 80,000-90,000; yield, 40,000-50,000; cannot be machined readily and is usually finished by grinding.

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CASTOLOY—Detroit Alloy Steel Co., Detroit. Furnished as castings. Chromium 12-14, carbon 1.5-1.6, cobalt .70, molybdenum .85; semiresistant; heat resistant to 1000 degrees Fahr.; medium abrasion resistance; tensile strength, ult., 100,000 lbs. per sq. in.; compressive strength, ult., 350,000 lbs. per sq. in.; medium ductility; good bearing and magnetic properties; used for bearings, cams, valve seats and spindles.

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CECOLLOY — Chambersburg Engineering Co., Chambersburg, Pa.

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A; carbon 3.00; molybdenum .50, nickel .60; shock resistance, vibration damping, and close grain.

1—*Corrosion resistant;* 2—*Heat resistant;* 3—*Abrasion resistant;* 4—*High tensile strength;* 5—*High ductility;*
6—*Bearing application;* 7—*Electrical uses;* 8—*Heat treating;* 9—*Low specific gravity;* 10—*Machinability*

B; carbon 2.80, molybdenum .50, chromium .35; also has shock resistance, is vibration damping and has close grain in heavy sections.

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C; carbon 3.00, molybdenum .50; nickel 1.50; properties similar to type A.

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CECOLLOY IRON—Chambersburg Engineering Co., Chambersburg, Pa.; carbon 3, manganese .90, silicon 1.30, nickel 60, molybdenum .50; suitable for casting in cement-bonded sand molds; resists corrosion to atmospheric conditions and acids; has tensile strength 56,000 lbs. per sq. in.; brinell hardness of 255; for steam cylinder liners, cylinders, rings and valves; also beds for heavy duty machine tools.

CERROBASE—Cerro de Pasco Copper Corp., New York. Bismuth-lead casting alloy which expands on cooling; melts at 255 degrees Fahr.; tensile strength 6100 lbs. per sq. in.; recommended for master patterns, electroforming, engraving machine models, etc.

CERROBEND—Cerro de Pasco Copper Corp., New York. Bismuth-lead-tin-cadmium casting alloy which expands on cooling and has the extremely low melting temperature of 160 degrees Fahr.; tensile strength of 6000 lbs. per sq. in.; useful as a fusible alloy and as a filler for tube bending.

CERROMATRIX—Cerro de Pasco Copper Corp., New York. Bismuth-lead-tin-antimony casting alloy which melts at 248 degrees Fahr. and expands on cooling; tensile strength 13,000 lbs. per sq. in.; used for locating and anchoring machine parts in cored holes.

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CHACE THERMOSTATIC METAL — W. M. Chace Co., Detroit. Thermostatic bimetals; a number of combinations including alloys of nickel-iron, nickel-iron-chromium, nickel-iron-manganese, pure nickel, brass, bronze, etc.; responsive to various temperature ranges and provide a wide range of deflection rates and electrical resistivities; for temperature control elements in controllers, recorders, indicators, circuit breakers, etc.

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CHAMET BRONZE—Chase Brass & Copper Co., Waterbury, Conn. Copper 62, tin .65, zinc 37-35; for general use where relatively corrosion resistant brass is required.

Leaded; Copper 62, tin .65, lead 1.5, zinc 35.85; for forming of parts on automatic screw machines where a free-cutting relatively high-strength corrosion resistant brass is required.

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CHASE—Chase Brass & Copper Co. Inc., Waterbury, Conn.

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Admiralty Brass; copper 71, tin 1, zinc 28; standard alloy for condenser tubes, particularly for salt or brackish water.

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Cupro-Nickel; copper 70, nickel 30, and copper 80, nickel 20; largely used for condenser tubes particularly for extreme service in very corrosive waters.

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Free-cutting commercial bronze; copper 89, lead 2, zinc 9; for screw machine parts requiring good physical properties and high corrosion resistance.

Also various high and low brasses for a variety of mechanical parts.

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CHASE 444 BRONZE—Chase Brass & Copper Co., Waterbury, Conn. Copper 88, tin 4, lead 4, zinc 4; a high-strength, free-machining, general purpose alloy particularly recommended for bushings and bearing applications. For bushings it shows excellent resistance to wear and deformation.

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CHASE TELLURIUM COPPER—Chase Brass & Copper Co., Waterbury, Conn.

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Type A; copper 99.5, tellurium .5; furnished in finished rods or bars and tubing for hot forging, extruding, turning, boring, etc.; corrosion resistant; resists heat up to 450 degrees Fahr.; medium abrasion resistance; tensile strength 32,000-55,000 lbs. per sq. in.; medium ductility; brinell hardness, untreated 90; for electrical connections, parts for electric motors, switches, etc.

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Type B; copper 98.3, nickel 1, tellurium .5 and phosphorus .2; resists heat up to 450 degrees Fahr., medium abrasion resistance; tensile strength 40,000-70,000 lbs. per sq. in.; specific gravity, .323 lbs. per cu. in.; brinell hardness, untreated 50, heat treated 125; for marine hardware, locks, bolts, etc.

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CHROMALOID—American Nickeloid Co., Peru, Ill. Chromium bonded to nickel-bonded zinc, latter serving as rustproof, flexible and inexpensive white metal base. Available in variety of brilliant finishes and patterns, as sheets, flat strips and coiled strip for continuous feed automatic presses. Can be supplied with quick removable, gum adhered paper covering permitting drawing and forming without marring pre-finish. For reflectors, automotive details, washing machine parts, and for other stamped and formed parts requiring brilliant, permanent finish.

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CHROMAX—Driver-Harris Co., Harrison, N. J. A heat resisting alloy used for carburizing containers or furnace parts; nickel 35, chromium 19, and balance iron.

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CHROMEL—Hoskins Mfg. Co., Detroit.

Alloy 502; nickel 35, chromium 18½, balance mainly iron; supplied as castings, or as rod, bars and strips. For general heat resistant applications and for mechanical and load-carrying members which are heated to 2000 degrees Fahr.

Alloy 670; chromium 25, nickel 12, balance mainly iron; supplied as castings or as rod, bars and strips; for high temperature applications where sulphur corrosion must be withstood.

Grade A; nickel 80, chromium 20, supplied as castings or as rod, bars, wire and strip; used for electric heating elements up to 2100 degrees Fahr.

Grade C; nickel 60, chromium 16, balance mainly iron; used for electric heating elements to 1700 degrees Fahr.; also used for rheostatic purposes; supplied as castings, or as rods, bars and strip.

Grade D; nickel 35, chromium 18½, balance mainly iron; used for heating elements to 1400 degrees Fahr.; available cast, or as wire, rod and strip.

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CHROMEWELD 4-6—Lincoln Electric Co., Cleveland. For the welding of steels commonly known as 5 per cent chromium steels. Annealed at 1550-1600 degrees Fahr.; cooled slowly and stress relieved at 1400 degrees Fahr. will have tensile strength of 80,000-90,000 lbs. per sq. in.; yield point 55,000-65,000 lbs. per sq. in.; elong. in 2 in., 24-30 per cent; reduction in area 60-70 per cent; brinell hardness, 155-175.

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CIMET — Driver-Harris Co., Harrison, N. J. Nickel 10-12, chromium 26-28, and balance iron; castings for furnace parts in high sulphur atmospheres, and for acid resisting castings in the form of pump impellers, piping, etc.

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CIRCLE L—Lebanon Steel Foundry, Lebanon, Pa. This tradename covers castings in forty-three different types of alloys including the following:

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No. 1; manganese 1.40, carbon .35, with vanadium or molybdenum.

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No. 2; carbon .32, chromium .75, molybdenum .30, manganese 1.40; for crankshafts, airplane parts, valves and other castings.

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No. 3; carbon .50, chromium 1.25, vanadium .12, molybdenum .40, manganese .75; for gears and cams.

No. 5; carbon .30, chromium .75, nickel 1.75, molybdenum .30; for highly stressed parts.

No. 6; carbon .15, nickel 1.75, molybdenum .25; for cams, gears and other case hardened parts.

No. 9; carbon .25, molybdenum .45; for parts subject to temperature.

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No. 10; carbon .20, chromium 5.50, molybdenum .55; for high pressure and high temperature applications in the oil industry.

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No. 11; carbon .25, chromium 18; hard stainless steel; for parts subject to nitric acid corrosion.

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No. 12; carbon .10, chromium 13; stainless steel; for chemical apparatus, etc.

No. 13; carbon .25, chromium 13; for stainless steel parts where high hardness is essential.

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No. 15; carbon .30, chromium 27; heat and corrosion service.

No. 22; carbon .07 max., chromium 19.50 nickel 9; for miscellaneous stainless parts and castings to be polished. Also made with molybdenum and/or columbium as required.

No. 23; carbon .15, chromium 19.50, nickel 9; miscellaneous stainless alloy castings.

No. 30; carbon .15, chromium 24, nickel 10; for valves, pumps and miscellaneous parts for the paper industry.

No. 31; carbon .22, chromium 28, nickel 11; resistant to temperatures up to 2000 degrees Fahr.

No. 32; carbon .50, chromium 15, nickel 35; heat resisting castings requiring strength at elevated temperatures.

No. 34; carbon .06, chromium 20, nickel 30, molybdenum 3, plus copper.

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CLOVERLEAF BABBITT—E. A. Williams & Son Inc., Jersey City, N. J. Babbitt metal in grades A, B and 0 and 1, 2, 3 and 4, for bushings, bearings, etc.

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COLALLOY—Colonial Alloys Co., Philadelphia. Furnished in sheets, plates, circles, strip, tubes, coils, pipes, rods, angles, shapes and other forms; can be easily formed, bent, machined, fabricated, welded, etc.; has wide range of tensile strengths, brinell hardness; medium and high ductility; good bearing properties; nonmagnetic; for use as disks, chucks, pulleys, guards, mountings, feed brackets, lever knobs, covers, spindles, rings, collars, bushings, housings, tubes, fastenings, etc.

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COLUMBIA—Columbia Steel & Shafting Co., Pittsburgh; furnished in rods and bars, tensile strength is high; bearing properties good; material machines freely.

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COMMERCIAL—Buckeye Brass & Mfg. Co., Cleveland. Cored and solid bronze bars; copper 80, tin 10, lead 10; for bushings bearings and bars.

See advertisement, Page 12-D

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COMPO—Bound Brook Oil-less Bearing Co., Bound Brook, N. J. Oil-retaining porous bronze bearings and washers; copper 88.75, tin 9.75, graphite 1.5; porous structure containing as high as 35 per cent of oil or other lubricant by volume. Used in automobiles, airplanes, household appliances, machine tools, electric motors, etc.

See advertisement, Page 59-D

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COOPER ALLOY—(Formerly Sweetaloy)—Cooper Alloy Foundry Co., Elizabeth, N. J.

No. 16; 18 per cent chromium iron.
No. 17; 18 chromium and 8 nickel.
No. 18; 22 nickel and 10 chromium.
No. 19; 28 per cent chromium.
No. 20; 36 nickel and 18 chromium.
No. 21; 65 nickel and 15 chromium.
No. 22; 28 chromium and 10 nickel; this and above alloys furnished in castings for chemical plant, paper mill, textile and food processing machinery.

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COPEL—Hoskins Mfg. Co., Detroit. Copper 55, nickel 45; used mostly for thermostatic purposes, also for heating elements to 800 degrees Fahr. Temperature coefficient of resistance is practically nil.

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COPPEROID—American Nickeloid Co., Peru, Ill. Copper bonded to zinc, latter serving as rust-proof, flexible and inexpensive white metal base. Available in variety of brilliant finishes and patterns, as sheets, flat strips and coiled strip for use in continuous feed automatic presses. Can be supplied with quick removable gum adhered paper covering permitting drawing and forming operations without marring pre-finish. For machinery trim, nameplates, change gear index plates, etc.

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CRAMP ALLOYS—Cramp Brass & Iron Foundries Co., Philadelphia.

No. 49; furnished in rough bars or billets, rods or bars, and sand castings; resists heat to 400 degrees Fahr.; high abrasion resistance; tensile strength 120,000 lbs. per sq. in.; compressive strength 55,000; medium ductility; specific gravity, 6.8; good bearing properties; used for heavy duty, slow moving loads.

No. 99; furnished in rough bars or billets and rods or bars; resists corrosion by sulphuric,

1—*Corrosion resistant;* 2—*Heat resistant;* 3—*Abrasion resistant;* 4—*High tensile strength;* 5—*High ductility;* 6—*Bearing application;* 7—*Electrical uses;* 8—*Heat treating;* 9—*Low specific gravity;* 10—*Machinability*

sulphurous, acetic acids; heat resistant to [illegible]0 degrees Fahr.; high abrasion resistance; tensile strength 55,000 lbs. per sq. in.; compressive strength 22,000; good bearing properties; brinell hardness, untreated 100; used for high speed bearings and acid resisting parts.

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CRASFLOY—Continental Roll & Steel Foundry Co., East Chicago, Ind. Hard alloy gray iron rolls made in four grades: mild, medium, hard and super hard.

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CROMIN D — Wilbur B. Driver Co., Newark, N. J. Nickel-chromium-iron; high resistivity, for use in low temperature work.

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CROMONITE—Continental Roll & Steel Foundry Co., East Chicago, Ind. Hard alloy chill roll made in four grades, mild, medium, hard and super-hard for special applications.

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CUFERCO—Westinghouse Electric & Mfg. Co., East Pittsburgh. Copper-iron-cobalt alloy resembling Cupaloy, but has greater strength, higher heat resistivity, more mechanical endurance, and somewhat lower electrical conductivity.

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CUMLOY—West Steel Casting Co., Cleveland. A molybdenum-vanadium-nickel alloy for steel castings such as cams, gears, levers, and indexing mechanism parts.

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CUPALOY—Westinghouse Electric & Mfg Co., East Pittsburgh, Pa. Copper base alloy containing chromium and silver; thermal and electrical conductivity 80-90 per cent pure copper; tensile properties of steel; brinell hardness of 140-160; applications include spot-welding tips, seam-welding wheels and rolls, mechanical parts carrying heavy current, etc. Licensees: A. W. Cadman Mfg. Co., Pittsburgh.

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CUPRON—Wilbur B. Driver Co., Newark, N. J. Nickel copper alloy; supplied in wire and strip form; for rheostats, voltmeters, shunts and other resistances operated below red heat; has moderate resistivity; resists heat to 1000 degrees Fahr.

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D-H-S BRONZE—Koppers Co., Bartlett-Hayward Div., Baltimore. Furnished in rough bars or billets, rods or bars, also as sand castings; zinc 21-25, copper 61-65, hardener (aluminum, manganese and iron) 13-15; resists corrosion, heat resistant to 400 degrees Fahr.; high abrasion resistance; tensile strength, 125,000-130,000 lbs. per sq. in.; compressive strength 90,000; specific gravity .28 lbs. per cu. in.; nonmagnetic; brinell hardness, untreated 255-260; used for heavy-duty bearings, gears, guides, screws, stems, nuts, etc.

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DM-45—Timken Steel & Tube Div., The Timken Roller Bearing Co., Canton, O. Carbon .40-.50; manganese .40-.70, silicon .50-.80, chromium 1-1.5, molybdenum .45-.65; furnished in rough bars or billets, and finished rods or bars, for hot forging, turning, boring, etc., into parts. Material resists heat to 1100 degrees Fahr.; tensile strength, 150,000 lbs. per sq. in., min., heat treated; medium ductility; and brinell hardness, untreated 185, heat treated 411 max. For bolts, studs and other highly-stressed parts used at elevated temperatures.

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DM STEEL—Timken Steel & Tube Div., The Timken Roller Bearing Co., Canton, O. Carbon .15 max., manganese .30-.60, silicon .50-1, chrome 1-1.5, molybdenum .45-.65, phosphorus .03 max., sulphur .03 max.: furnished in rough bars or billets, finished rods or bars, and tubing, for hot forging, welding, turning, boring, etc. into parts. Material resists heat to 1100 degrees Fahr.; tensile strength, ult., 60,000 lbs, per sq. in., min.; medium ductility; fair weldability; and brinell hardness, annealed 163 max. Used for oil refinery field.

Type 2; similar to above with slightly varied analysis; resists heat to 1050 degrees Fahr.; tensile strength, ult., 60,000 lbs. per sq. in. min.; medium abrasion resistance; fair weldability; brinell hardness, annealed 163 max. For oil refinery field, also.

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DEFIHEAT—Rustless Iron & Steel Corp., Baltimore. No. 446 stainless type carbon .35 max., chromium 23 to 30; resists nitric and sulphuric acids, also heat to 2000 degrees Fahr.; for furnace parts and other applications involving high heat.

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DEFIRUST—Rustless Iron & Steel Corp., Baltimore.

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No. 410 stainless type; carbon .15 max., chromium 10-14; hardening type of stainless steel for turbine blades.

No. 416 machining type; carbon .15 max., sulphur .15 and chromium 12-14; hardening type of stainless steel possessing free-cutting properties.

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DEFISTAIN—Rustless Iron & Steel Corp., Baltimore.

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Types 302, 304 and 308; carbon .08-.12 max. or .08 max., manganese 2 max., chromium 18-22, nickel 8-12; retains high tensile strength and resistance to creep to 1300 degrees Fahr.; nonmagnetic; resists nitric acid, salt air, and food; resists heat to 1600 degrees Fahr.; recommended for machinery parts which come in contact with food.

Type 303, machining; carbon .20 max., sulphur .15 min., chromium 18-20 and nickel 8-10; has high ductility and free-cutting properties; resists heat to 1550 degrees Fahr., and has tensile strength to 200,000 lbs. per sq. in.; recommended for same purposes as above where free cutting is desirable.

Rustless 18-12 Mo., types 316-317; carbon .09 max., chromium 16-20, nickel 14 max., molybdenum 2-4; corrosion resistant; used for parts in paper and pulp, and chemical industries.

Columbium type 347; carbon .10 max., chromium 17-20, nickel 8-12; columbium ten times carbon; same properties as Defistain except welded equipment does not require annealing after welding; material is stabilized.

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DELLOY—Delloy Metals, Philadelphia.

Type No. 9; chromium 30.7, cobalt 48.2, tungsten 17.5, carbon 2.2; corrosion resistant; resists heat to 2700 degrees Fahr.; high abrasion resistance; tensile strength 60,000 lbs. per sq. in.; good weldability; for parts where wear resistance is required.

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DEWARD—Allegheny-Ludlum Steel Corp., Pittsburgh. Carbon .9, manganese 1.50, molybdenum .30; for holders for thread chasers and gang punches. Oil hardening.

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DIAMOND G BRONZE—E. A. Williams & Son Inc., Jersey City, N. J. For bearings, bushings and mill brasses, either finished or in the rough.

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DIXOILBRONZ—Thos. F. Seitzinger's Sons, Atlanta, Ga. Bearing bronze, copper base, balance tin and lead with no agents or hardener; resists corrosion due to high lead content; heat resistant to 700 degrees Fahr.; tensile strength, ult., 18,000-30,000 lbs. per sq. in.; compressive strength, ult., 7800-14,000; bearing properties, good; recommended for bearings, bushings, gears, pump runners, pump liners, and for oil field equipment.

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DOLE THERMOSTATIC BIMETAL—The Dole Valve Co., Chicago. Furnished in strips and fabricated elements; for stamping and coiling; good magnetic properties; good weldability; recommended heat treatments are 600-700 degrees Fahr.; free end of thermal element deflects proportionately with changes in temperature; used to provide protection against excessive temperature and temperature control at predetermined temperatures.

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DOLER-ALUMIN — Doehler Die Casting Co., New York. Aluminum base die castings. Composition suited to meet stringent requirements, as high tensile strength, impact strength, hardness, corrosion resistance, thermal conductivity and electrical conductivity.

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DOLER-BRASS—Doehler Die Casting Co., New York. Brass die castingss. Composition suited to meet varying conditions. Tensile strength to 100,000 lbs. per sq. in., and hardness to 180 brinell; excellent corrosion resisting properties.

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DOLER-MAG—Doehler Die Casting Co., New York. Magnesium base die castings made from the lightest of the commercial metals; one-third lighter than aluminum.

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DOLER-ZINK—Doehler Die Casting Co., New York. Zinc base die castings of maximum tensile and impact strength.

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DOWMETAL—The Dow Chemical Co., Midland, Mich.

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Alloy C; aluminum 9, manganese .1, zinc 2, magnesium remainder; furnished in ingot form for sand casting and permanent mold casting; corrosion resistant; heat resistant up to 400 degrees Fahr.; tensile strength 39,000 lbs. per sq. in.; compressive strength 60,000 lbs. per sq. in.; specific gravity 1.82; fair weldability; brinell hardness, untreated 60, heat treated 77; for moving parts on stationary and manually handled machines to reduce weight. Alloy has pressure tightness.

Alloy E; aluminum 6, manganese .20, remainder magnesium; plate, sheet and strip with good properties; available in hard rolled and annealed tempers.

Alloy FS; aluminum 2.7, manganese .2, zinc 1, remainder magnesium; used for moving parts on stationary and manually handled machines to reduce weight; general purpose wrought alloy with good weldability and salt-water resistance.

Alloy H; aluminum 6, manganese .20, zinc 3, remainder magnesium; sand castings and press forgings for aircraft and general usage; improved salt water resistance; may be heat treated to secure high tensile strength and toughness, or heat treated and aged to secure high yield strength with moderate toughness.

Alloy L; aluminum 2.5, cadmium 3.5, manganese .3, remainder magnesium; best hammer forging alloy, hammer forgings for aircraft and other industries.

Alloy M; manganese 1.5, remainder magnesium; plate, sheet, strip, extruded shapes, sand castings, die castings and forgings of moderate strength for all uses demanding maximum salt water resistance.

Alloy O; aluminum 8.5, manganese .2, zinc .5, remainder magnesium; simple press forgings and extruded sections of high yield strength.

Alloy R; aluminum 9, manganese .15, zinc .6, remainder magnesium; most generally used die casting alloy combining maximum toughness and elongation with good tensile and yield strengths.

Alloy J; aluminum 6.5, manganese .2, zinc .7, remainder magnesium; press forgings, extruded bars, rods and shapes, and tubes. Also plate and sheet with maximum properties.

Alloy X; aluminum 3, manganese .2, zinc 3, remainder magnesium; resists heat to 400 degrees Fahr.; tensile strength 44,000 lbs. per sq. in.; resistance to salt water; used for moving parts on stationary and manually handled machines to reduce weight.

Above alloys may be used in reciprocating, rotating or manually handled parts where light weight is desirable.

See advertisement, Page 15-D

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DRAGON—Allegheny Ludlum Steel Corp., Pittsburgh. Carbon .33, manganese .55, chrome .65, molybdenum .35; high degree of toughness with moderate hardness; water hardening; for use as bucket teeth, keys, pins, bolts, studs, etc.

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DRIVER-HARRIS 42 ALLOY — Driver-Harris Co., Harrison, N. J. Notable for its coefficient of linear expansion—approximately that of different grades of glass.

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DRIVER-HARRIS 52 ALLOY — Driver-Harris Co., Harrison, N. J. Alloy of nickel and iron which has been successfully used for sealing in glass and in which process no coating is required prior to the operation.

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DUCTILOY—Great Lakes Steel Corp., Div. of National Steel Corp., Ecorse, Detroit. Carbon 15, manganese .70, chrome .55, silicon .85, nickel .15, copper .20, zirconium .15, phosphorus .025, sulphur .025; furnished in rough bars or billets, finished rods or bars, sheets, strips, plates, for hot forging, stamping, extruding, turning, boring, welding, cold forming, etc.; abrasion resistance, medium; tensile strength, ult., 75,000-80,000 lbs. per sq. in.; ductility, high; specific gravity, 7.85; weldability, good; brinell

1—Corrosion resistant; 2—Heat resistant; 3—Abrasion resistant; 4—High tensile strength; 5—High ductility; 6—Bearing application; 7—Electrical uses; 8—Heat treating; 9—Low specific gravity; 10—Machinability hardness, untreated 160; fatigue and impact resistant; for frames, bases, small axles and power transmission shafting.

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DUPLEX—Crucible Steel Co. of America, New York.

No. 1; nickel 3.50, chromium 1.50; forging steel, for shafts and machine parts requiring high strength and toughness; also made in case carburizing type.

No. 2; nickel 1.75, chromium 1; also a forging steel for applications similar to those of No. 1, and made in case carburizing type.

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DUQUESNE SPECIAL—Continental Roll & Steel Foundry Co., East Chicago, Ind. Chrome molybdenum steel for rolls subject to severe service; also for abrasive castings.

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DURACAST—West Steel Casting Co., Cleveland. For steel castings of 90,000 lbs. per sq. in. tensile strength and brinell hardness of 180; cams, gears, etc.

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DURCO—Duriron Co. Inc., Dayton, O. Alloy steels (KA2S, KA2SMo., etc.); 18 chrome, 8 nickel, carbon max. .07, and other standard as well as special analyses preferred by users; for pumps, valves, fittings, castings for corrosive service, etc.

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DUREX—Moraine Products Div., General Motors Corp., Dayton, O. Product of powder metallurgy in iron, bronze and other metals; self-oiling bearings and various small parts for electric motors, automobiles, domestic and other machinery.

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DURICHLOR—Duriron Co. Inc., Dayton, O. Silicon 14.5, molybdenum 4, carbon .80, traces of phosphorus and sulphur, balance iron; for pumps, valves, pipe, castings for corrosive service, especially for hydrochloric acid and chloride solutions.

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DURIMET—Duriron Co. Inc., Dayton, O. Nickel 22, chromium 19, silicon, molybdenum and copper 5 approx., carbon .07 max., balance iron; for pumps, valves, bolts, nuts and castings for corrosive service, especially weak sulphuric acid.

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DURIRON—Duriron Co. Inc., Dayton, O., and licensees. Silicon 14.50, carbon .80, manganese .60, sulphur and phosphorus traces, balance iron; for pumps, valves, exhaust fans, mixing nozzles, and castings for handling acids and other corrosive liquids and gases.

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DURONZE ALLOYS — Bridgeport Brass Co., Bridgeport, Conn. High copper silicon bronzes alloyed with elements such as tin, iron, aluminum, etc.; possess high strength combined with corrosion resistance.

I; possesses excellent cold working properties; cold headed bolts and screws, average 100,000 lbs. per sq in. tensile strength; available in rod, wire and sheet form.

II; hot rolled sheet for making range boilers, automatic heaters and storage tanks by either electric arc or oxyacetylene welding methods; cold rolled strip used as a substitute for phosphor bronze spring metal; rod and wire used for making hot headed bolts and screw products; supplied in sheet, rod, wire, tube and ingot forms.

III; supplied in rod form; tensile strength about 100,000 lbs. per sq. in.; hot forgings about 90,000 lbs. per sq. in.; free machining for making screw machine parts, also for sucker rods for corrosive oil wells; ten per cent lighter than brass; excellent corrosion resistance; in ingot form may be used for making sand castings with tensile strength about 70,000 lbs. per sq. in.

IV; made into condenser tubes only; for resisting corrosion from aerated sea water.

V; wire for making difficult cold headed parts, screws, bolts; malleable; good corrosion resistance; tensile strength, about 100,000 lbs. per sq. in.; for outdoor use.

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DUTCH BOY BABBITT—National Lead Co., New York. Analysis varies for different bearing applications.

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DYNAMIC STEEL—Continental Roll & Steel Foundry Co., East Chicago, Ind.

C-2; carbon-manganese-nickel cast steel for parts requiring high physical properties; for tractor frames, locomotive castings, etc.

C-3; carbon-manganese-nickel cast steel for resisting wear after a preferential heat treatment; for sprockets, spindles, wheel centers, cross heads, etc.

C-3-A; carbon-manganese-molybdenum cast steel for parts requiring high physical properties, with machinability; for gears, racks, sprockets and miscellaneous castings.

C-4; nickel-vanadium alloy; heat treated, having high physical properties especially suitable for rolling mill pinions.

C-5; carbon-manganese-nickel-moly steel for rams and saw blocks; high physical properties and high impact value.

C-6; chromium cast steel for special abrasive and crushing work; for sand mills, rock crushers, etc.

C-7; carbon-chromium-nickel-molybdenum cast steel for castings requiring high physical and severe service qualities.

C-8; carbon-manganese-vanadium steel for air hardening.

C-10; carbon - chrome - molybdenum - vanadium steel for die blocks and crane wheels; superior wear resistance and high physical properties.

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DYN-EL—Alan Wood Steel Co., Conshohocken, Pa. Furnished in sheets, strips, and plates, for stamping, welding, cold and hot forming, etc.; abrasion resistance medium; tensile strength 70,000-80,000 lbs. per sq. in.; ductility high; weldability good; fatigue and impact values high; for structures requiring high strength.

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EASY-FLO—Handy & Harman, New York. Brazing alloy; silver 50, copper 15.5, zinc 16.5, cadmium 18; resists corrosion due to silver content; specific gravity 9.49; for brazing ferrous and nonferrous metals, particularly dissimilar metals and monel metal, stainless steel and other copper-nickel and chrome-nickel alloys. Has many electrical uses.

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ECONOMET—General Alloys Co., Boston. Nickel 30, chromium 10; resists heat to 1800 degrees Fahr.; tensile strength, 70,000 lbs. per sq. in.; for castings subject to high temperatures.

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ECONOMO—Wheelock Lovejoy & Co. Inc., Cambridge, Mass. Carbon .20 and .50 with alloy of molybdenum; free machining; for machine tool parts.

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EIS 45—Heppenstall Co., Pittsburgh. Carbon .85 chrome .12. Furnished for hot forging into parts. Used for shear blades for shearing medium heavy material.

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EIS 57—Heppenstall Co., Pittsburgh. Nickel chrome-molybdenum-steel, .6 carbon; for insert and hot die steel service.

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ELASTUF—Horace T. Potts Co., Philadelphia.

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Type A steel, heat treated; special analysis chrome vanadium steel; carbon .25-.35 up to 2 in. round, and carbon .45-.55 over 2 in. round; furnished in rough bars or billets and forgings, for turning, boring, etc. Has excellent tensile strength at elevated temperatures. Used where maximum strength, resistance to impact, fatigue, wear, shear or compression is required.

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Type A alloy steel, annealed; special analysis chrome vanadium steel; carbon .45-.55; furnished in rough bars or billets and forgings. Brinell hardness, untreated 200, heat treated 600. For parts which must be hardened and where maximum toughness is required such as cams, plastic molds, mandrels, clutch parts, etc.

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Type C. H. free machining case hardening steel, hot rolled; furnished in rough bars or billets, and finished rods or bars, for turning, boring, etc.; tensile strength 70,000 lbs. per sq. in.; high ductility; used for mass production parts needing machinability and excellent case hardening properties.

Licensees are: Brown-Wales, Boston; Beals, McCarthy & Rogers Inc., Buffalo; Equitable Equipment Co., New Orleans.

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ELASTUF CHRO-MOLY—Horace T. Potts Co., Philadelphia. Chrome - molybdenum alloy steel, hot rolled, heat treated; carbon .35-.45 up to 4 in. round, and .45-.55 carbon over 4 in. round; furnished in rough bars or billets and forgings, for turning, boring, etc. Used for heavy-duty parts requiring high tensile properties with exceptional impact strength.

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ELASTUF PENN—Horace T. Potts Co., Philadelphia. Hot rolled steel furnished in rough bars or billets, and finished rods or bars for hot forging, turning, boring, etc.; tensile strength 125,000 lbs. per sq. in.; medium ductility. Used where maximum strength in a carbon machinery steel is required or where untreated alloys of simpler type have been used.

ELECTROMET—Electro Metallurgical Sales Co., New York. A line of ferro-alloys and alloying elements of various analyses.

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ELECTRUNITE—Steel & Tubes Inc., Cleveland. Electric-welded tubing in stainless, carbon, copper bearing steel and rust-resisting copper molybdenum iron (Toncan). Square, rectangular, oval or other shapes in any size or gage where the periphery of the shape is not less than 2 1/32 in. or more than 16 in. For general mechanical purposes.

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ELKALOY—P. R. Mallory & Co. Inc., Indianapolis. A work-hardened alloy of copper, not heat-treatable, for spot and seam welding aluminum and its alloys, unpickled hot rolled steel, terne plate, tin plate, galvanized iron and other materials. A direct substitute for copper, it handles the same but is harder and lasts longer.

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ELKONITE—P. R. Mallory & Co. Inc., Indianapolis. Two definite classes of materials. One group based on copper and such refractory metals as tungsten, molybdenum and their carbides—combinations which produce material with good electrical conductivity and great wear-resistant qualities, for use as welding electrodes and contactors in oil-immersed circuit breakers. Another group is based on silver and refractory materials such as tungsten, molybdenum and their carbides, and has been developed primarily as a facing material for heavy duty electrical contacts and contactors for air breakers. This material can be used either in the form of a thin facing or as an insert with copper or copper alloy backing material.

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ELVERITE—Babcock & Wilcox Co., New York. Special chilled iron castings; for tube mill lining, car wheels, jaw crushers, sprockets, etc.

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ENDURO — Alloy Steel Div., Republic Steel Corp., Massillon, O. Stainless and heat resisting alloy.

Chromium-nickel group:

17-7; chromium 17, nickel 7, carbon .09-.20; used for automotive trim and for deep drawing where straight chromium types are not sufficiently ductile.

18-8; chromium 18, nickel 8, carbon cont. .08-.20; especially suited to resist atmospheric corrosion and corrosion reagents; for dairy and chemical plant equipment, food and meat processing machinery, high strength, light weight structural members, and for resistance to oxidation at elevated temperatures.

18-8-S; similar to 18-8 except carbon is kept under .08 which permits its use in welded equipment subject to severe corrosion.

18-8-FS; a special modification of 18-8 to develop greater softness and less work hardening; better adapted to successive drawing and spinning operations with less annealing than 18-8.

18-8-STi; 18-8-S to which titanium has been added for eliminating intergranular corrosion at high temperatures; used for airplane collector rings and exhaust manifolds, and other high temperature requirements.

18-8-SCb; 18-8-S plus columbium; for applications similar to those for which 18-8-STi is recommended. More efficient as carbide stabilizer and better corrosion resistance than titanium.

18-8-SMo; 18-8-S plus 2 to 3 molybdenum; resistant to acids encountered in paper and pulp processes, woolen dyeing and in chemical and pharmaceutical industries; recommended for severe corrosive conditions; good fabricating and welding properties.

18-8-B; 18-8 with 2 to 3 silicon; for resistance to oxidation in temperatures up to 1700 degrees Fahr.; for annealing boxes, furnace parts, etc.

18-8-FM; a free-machining type of 18-8 through addition of .07 min. selenium; machinability very good for chromium-nickel type—about 70 per cent that of screw stock. Corrosion resistance same or little less than 18-8.

1—*Corrosion resistant;* **2**—*Heat resistant;* **3**—*Abrasion resistant;* **4**—*High tensile strength;* **5**—*High ductility;* **6**—*Bearing application;* **7**—*Electrical uses;* **8**—*Heat treating;* **9**—*Low specific gravity;* **10**—*Machinability*

19-9-SMo; a modification of 18-8-SMo with higher alloy content for applications requiring somewhat higher corrosion resistance than 18-8-SMo.

HCN; chromium 25, nickel 12; for resistance to oxidation up to 2000 degrees Fahr.; fabricates, machines, and welds readily. High strength and creep at elevated temperatures. Not recommended for high sulphur conditions at high temperatures.

HCN-Low Carbon; a variation of HCN with carbon .80 max. for applications involving welding and corrosion resistance to eliminate carbide precipitation.

NC-3; chromium 25, nickel 20, silicon 2 max.; for maximum heat resistance. Best strength and creep at high temperatures, but may be attacked if sulphur present in gases. Resistant to carburizing.

S-Turbine Quality; chromium 11.5-13, carbon .15 max. used for applications where corrosion resistance and physical strength are needed at medium high temperatures.

S-High Carbon; a straight chromium, high carbon grade for heat treating for high hardness applications.

Straight chromium group:

S-1; chromium 10-14, carbon .15 max., responds readily to heat treatment and is recommended where strength, toughness and hardness are required; for pump shafts, valve seats and stems, nuts and bolts, etc.

S-1 Nickel; a modification of S-1 with addition of 2 max. nickel for somewhat better physical properties than S-1.

FC; free machining grade of S-1 analysis. Machines nearly as well as screw stock. Fairly resistant to the atmosphere, organic and fruit acids, etc. Can be hardened by heat treatment up to about 400 brinell. Considerably more care and control required in forging operation than with S-1.

FC High Carbon; a high carbon variation of FC having better physical properties than FC.

AA; chromium 14-18, carbon .12 max.; good corrosion resistance and heat resistant to 1500 degrees Fahr.; general corrosion resistance, fabricating and welding properties inferior to 18-8; for bicycle fenders, oil burner parts, etc.

AA High Carbon; a variation of AA with somewhat better physicals.

AA-FM; a free-machining codification of AA with machinability about 85-90 per cent of Bessemer screw stock.

HC; chromium 23-30; heat resistant to 2000 degrees Fahr.; not affected by sulphur gases; strength and creep at high temperatures not as good as the chromium-nickels.

18-23; chromium 18-23; high heat resisting properties; good resistance to scaling, but strength and creep lower than chromium-nickel types; for furnace parts, etc.

4-6 per cent; chromium 4-6 with several carbon ranges to .25 and with or without addition of molybdenum or columbium, titanium, aluminum and tungsten; additions of columbium, titanium or aluminum practically eliminate air hardening on welding; corrosion and heat resistance considerably superior to that of carbon steels, and with fair strength at high temperatures; for oil refinery and furnace parts.

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ERMAL—(Z-Metal)—Erie Malleable Iron Co., Erie, Pa. A spheroidized pearlitic malleable cast iron; for castings requiring rigidity, high tensile strength, and abrasion resistance. Suitable for heat treatment.

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ERMALITE—Erie Malleable Iron Co., Erie, Pa. Wear-resisting alloy iron; for gears, wearing plates, friction drums and other parts subject to high stresses or wear.

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EVERDUR — American Brass Co., Waterbury, Conn.

Alloy No. 1010; copper 96, silicon 3, manganese 1; uses include tanks and sewage disposal apparatus.

Alloy No. 1015; copper 98.25, silicon 1.50, manganese .25; easily fabricated by all methods including welding; used for tubes, bolts and screws.

Alloy No. 1000; casting alloy; copper 90.94, manganese 1.01, silicon 4.

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FARRELL'S 85—Farrell-Cheek Steel Co., Sandusky, O. Specially processed steel castings for resisting abrasion, and possessing high strength, toughness and rigidity; tensile strength up to 150,000 lbs. per sq. in.; used for parts subject to shock, high stress, overload, wear and abrasion.

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FARRELL'S HARD EDGE—Farrell-Cheek Steel Co., Sandusky, O. Furnished as sand castings; high abrasion resistance; high tensile strength and ductility; brinell hardness, heat treated 650-700 and higher; for crane wheels, cast tooth gears, rollers, sheaves, sprockets, traction wheels.

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FEDERAL-MOGUL BRONZES — Federal-Mogul Corp., Detroit.

F1; a gear bronze suitable for heavily loaded piston pin bushings, etc.

F2; lead bronze for average bushing application.

F3; used largely as backs for babbitt-lined bearings.

F5; widely used for babbitt-lined bearing backs and for bushings where service is not severe.

F6; for average bushing applications.

F8; good casting and machining qualities.

F11; for piston pin bushings and other low speed, heavily loaded applications.

F13; suitable for many of the uses to which F1 is applied.

F15; has 20 per cent lead and may be used safely under adverse lubrication conditions.

F16; because of high lead content may be used where only occasional lubrication is possible.

F18; high lead alloy of good casting characteristics.

F19; strong ductile alloy of average hardness with bearing qualities corresponding to other low lead compositions.

F20; a hard bronze used for gears and worm wheels where requirements are severe; also aluminum bronze and special analysis bronzes.

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FERROWELD—Lincoln Electric Co., Cleveland. For arc welding cast iron. Has steel base to give solid weld on cast iron of greater tensile strength than the cast iron itself. Due to low current which can be used, hardening effect usually present along the line of fusion is materially reduced.

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FIRTHALOY—Firth-Sterling Steel Co., McKeesport, Pa. Highly developed form of sintered carbide adapted to wire drawing dies, extrusion dies and similar purposes.

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FIRTHITE — Firth-Sterling Steel Co., McKeesport, Pa. Hard metal composition of sintered carbides furnished in number of grades to form wearing surfaces or the edges of cutting tools.

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FIVEPOINT DEEPHARD STEEL—Foote Brothers Gear & Machine Corp., Chicago. Nickel-molybdenum alloy, for hot forging, turning, boring, etc.; resists heat to 250 degrees Fahr. steady, and 300 degrees Fahr. intermit.; abrasion resistance, high; tensile strength, ult., 216,000 lbs. per sq. in.; ductility, high; bearing properties, good; for use where abrasion, erosion, fatigue and shock resisting qualities are desired.

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FLAMALOY—Detroit Alloy Steel Co., Detroit. Furnished as castings. Carbon .35-.45, manganese 1-1.25, chromium 1-1.10, copper .90-1, molybdenum .30-.45; medium abrasion resistance; tensile strength, ult., 130,000 lbs. per sq. in.; high ductility; recommended heat treatments approx. 1500 degrees Fahr. water quenched; brinell hardness, untreated 200, heat treated 630; for miscellaneous machine parts.

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FLEETWELD—Lincoln Electric Co., Cleveland. Shielded arc electrode for welding mild steel.

Type 5; for flat, vertical and overhead welding. Tensile strength, 65,000-75,000 lbs. per sq. in.; ductility, 20 to 30 elong. in 2 in.; impact resistance, 30-70 ft. lbs. (Izod); density 7.84-7.86 grams per c.c.; corrosion resistance greater than mild steel.

Type 7; for general purpose welding and where fit-up is not of the best; low spatter and slag loss, high burn-off rate. Physical properties as welded; tensile strength, 70,000-80,000 lbs. per sq. in.; yield point 55,000-66,000 lbs. per sq. in.; ductility, approximately 17 per cent elong. in 2 in.; specific gravity, 7.80.

Type 8; heavily-coated electrode of shielded arc type for fillet welding in down positions only. Capable of producing fillets, (one plate vertical), up to 3.8 in size in one pass. Tensile strength, 65,000-75,000 lbs. per sq. in.; yield point 47,000-63,000 lbs. per sq. in.; elong. 20 to 30 per cent in 2 in. Can be used with either alternating or direct current.

Type 9; heavily-coated electrode of shielded arc type specifically for flat welding of deep groove joints. Physical properties as welded; tensile strength, 66,000-74,000 lbs. per sq. in.; yield point, 55,000 to 60,000 lbs. per sq. in.; elong. 20 to 30 per cent in 2 in.; specific gravity, 7.85 to 7.86; operates either with d.c. or a.c.

Type 9-HT; heavy-coated electrode of shielded arc type for deep grove welding in flat position of high tensile steels.

Type 10; for downhand welding on flat surfaces for finish bead welding and to provide full slag coverage and smoothness. Can be used with either direct or alternating current normal or reverse polarity.

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FRANKITE—Frank Foundries Corp., Moline, Ill.

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E-212; low carbon electric furnace iron; pressure resistant and long-wearing dense grain in heavy sections; for hydraulic bodies, refrigerator parts, compressor cylinders, etc. Good machinability.

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E-450; nickel 14, chromium 2, copper 6, electric furnace Ni-Resist. For corrosion resistance, heat resistance to 1500 degrees Fahr.; machinability fair.

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E-604; nickel 4½, chromium 1½, electric furnace Ni-Hard white iron. Combats corrosion; for mixer blades, ash chutes, scrapers, grinding burs, etc.; machinability by grinding

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E-830-N; chromium 30, nickel 3, low carbon; heat resistant; for continuous oven kilns, cement kiln cooler parts, furnace supports, etc.; machinability fair.

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FRONTIER—Frontier Bronze Corp., Niagara Falls, N. Y.

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No. 40 Ti-Aluminum; aluminum-chrome-magnesium-titanium-zinc alloy; furnished in rough bars or billets, finished rods or bars, tubing, sheets, and as castings; resists corrosion caused by salt water; resists heat to 600 degrees Fahr.; abrasion resistance, high; tensile strength, ult., 35,000-40,000 lbs. per sq. in.; compressive strength, ult., 30,000-35,000; brinell hardness, untreated 90; for use where strength at high temperatures is required.

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No. 5 Alloy; copper-aluminum and iron alloy, furnished as castings; tensile strength, ult., 60,000-95,000 lbs. per sq. in; compressive strength, ult., 22,000-65,000 lbs. per sq. in.; ductility, medium; brinell hardness, untreated 130, heat treated 140-200; for parts where high fatigue is required.

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GIBSILOY—Gibson Electric Co., Pittsburgh. Electrical contacts having high ductility, good weldability and machinability.

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GLOBE STAINLESS STEEL—Globe Steel Tubes Co., Milwaukee. Seamless steel tubing furnished in common steels as well as most of grades of SAE alloys, and stainless or corrosion resisting steel.

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GLYCO BABBITT—Joseph T. Ryerson & Son, Inc., Chicago. General tradename covering a group of specially processed lead base alloys including:

Turbo-Glyco; for high speed, heavy-duty; average brinell hardness, 30.

Marine Glyco; for electric motor and marine work; average brinell hardness 27.

Standard Glyco; free flowing, general purpose; average brinell hardness 24

Heavy pressure mill Glyco; high resistance to crushing loads; average brinell hardness 23.

Transmission Glyco; for line shafting and transmission work; average brinell hardness, 22.

See advertisement, Page 22-D

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GRAMIX—The United States Graphite Co., Saginaw, Mich. Bearing bronze; resists heat to 300 deg. Fahr.; tensile strength, 12,000 lbs. per sq. in.; compressive strength 100,000; specific gravity, 5.9-6.1 (apparent density); brinell hardness, untreated, 500 kilograms—28; used for bearings, contacts, slides and thrust bearings.

1—Corrosion resistant; 2—Heat resistant; 3—Abrasion resistant; 4—High tensile strength; 5—High ductility; 6—Bearing application; 7—Electrical uses; 8—Heat treating; 9—Low specific gravity, 10—Machinability

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GRAPHITAR—United States Graphite Co., Saginaw, Mich. Graphitic bronze; resists corrosion caused by most chemicals and atmosphere; resists heat to 5000 degrees Fahr. when reducing; tensile strength 5000 lbs. per sq. in; compressive strength 20,000 lbs. per sq. in.; used for antifriction machine parts.

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GRAPH-MO—Timken Steel & Tube Div. The Timken Roller Bearing Co., Canton, O. Carbon 1.50, silicon .80, manganese .40 max., phosphorus and sulphur .025, manganese .025, molybdenum .25; furnished in hot-rolled bars or billets, finished rods or bars, seamless tubing, wire, strips, sheets and plates, for hot forging, stamping and welding into parts. Has high abrasion resistance; tensile strength, ult., 85,000 lbs. per sq. in., min.; medium ductility; fair bearing properties; good weldability; recommended heat treatments for annealing, normal 1600 degrees Fahr.; oil quenched, 1475-1550 degrees Fahr.; brinell hardness, untreated 197, heat treated 745. Used for sliding or rotational service.

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GRAPHO—Lehigh Babbit Co., Allentown, Pa. A homogeneous mixture of graphite and babbitt which can be poured in the usual way; recommended for bearings subject to lubricating difficulties.

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GRAPH-SIL—Timken Steel & Tube Div., The Timken Roller Bearing Co., Canton, O. Carbon 1.50, silicon .90-1, manganese .40 max., phosphorus and sulphur .025 max.; furnished in hot-rolled bars or billets, finished rods or bars, seamless tubing, wire, sheets, strips and plates, for hot forging, stamping, welding, turnings, boring, etc. Tensile strength, ult., 97,000 lbs. per sq. in., min.; abrasion resistance, high; medium ductility; good bearing properties and weldability; for use as cylinder liners and in sliding or rotational service.

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GRAPH-TUNG—Timken Steel & Tube Div., The Timken Roller Bearing Co., Canton, O. Carbon 1.50, manganese, .40 max., phosphorus and sulphur .025, max., silicon, .65, molybdenum .50, tungsten 3; furnished in hot-rolled bars or billets, finished rods or bars, wire, sheets, strips and plates, for hot forging, stamping and welding. Has high abrasion resistance; tensile strength, ult., 95,000 lbs. per sq. in., min.; medium ductility; fair bearing properties; good weldability; and brinell hardness, untreated 229, heat treated 840; used for sliding and rotational service.

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HALCOMB—Halcomb Steel Div., Crucible Steel Co. of America, Syracuse, N. Y.

Stainless Steels: Grade A, chrome 12.5; Grade B, chrome 17.

Stainless Irons: FM2, chrome 12; for free machining corrosion resistant parts.

No. 12; chrome 12 to 13.
No. 17; chrome 15 to 16.
No. 20; chrome 18 to 20.
No. 27; chrome 24 to 26.

NCR-238 and Rezistal: stainless steels in various grades for corrosion and heat resistant parts.

HANDY FLUX—Handy & Harman, New York. For brazing steel, stainless steel, monel metal, nickel, copper, beryllium-copper, brass, bronze, aluminum bronze and various other ferrous and nonferrous metals and alloys.

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HARDTEM—Heppenstall Co., Pittsburgh. Carbon .5, nickel-chrome-molybdenum die steel; for die blocks, shafting, etc.

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HARDWELD—Lincoln Electric Co., Cleveland. High carbon arc welding electrode having brinell of 225-488; provides dense, tough surface of moderate hardness to enable various steel parts to resist shock and abrasion; for locomotive or crane tire flanges, etc.

Type 50; medium carbon steel electrode for building up steel parts and surfaces. Deposit has considerable resistance to deformation and wear, and is machinable at slow speed. Coating stabilizes the arc and permits deposition of a tough, dense medium carbon steel. Hardness, deposited on straight carbon steel and allowed to cool naturally, 20 to 35 Rockwell C.

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HASCROME—Haynes Stellite Co., Kokomo, Ind. Alloy of chromium, manganese and iron; welding rod for hard-facing parts subject to abrasion and impact.

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HASTELLOY—Haynes Stellite Co., Kokomo, Ind. Corrosion-resistant, nickel-base alloys for piping, tanks, pump parts, valves, vessels, etc.

A and B; nickel, molybdenum and iron.
C; nickel, molybdenum, chromium and iron.
D; nickel and silicon.

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HAYNES 93—Haynes Stellite Co., Kokomo, Ind. Ferrous alloy welding rod for hard-facing metal wearing parts; abrasion resistance, high; tensile strength, ult., 43,040 lbs. per sq. in. average; Rockwell hardness, untreated C-62, heat treated, C-67.

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HAYNES STELLITE—Haynes Stellite Co., Kokomo, Ind. Nonferrous cobalt-chromium-tungsten alloys for corrosion and wear-resistant castings, metal-cutting tools, hard-facing welding-rod for parts subject to abrasion or a combination of abrasion, heat and corrosion.

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HAYSTELLITE—Haynes Stellite Co., Kokomo, Ind. Cast tungsten carbide; inserts, tube rod, and composite rod (welding) for hard-facing oil-well drilling tools, dredge cutter blades, etc.

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HEPPENSTALL 2 C 30—Heppenstall Co., Pittsburgh. Nickel-chrome-molybdenum steel, carbon .3; for shafting where high torsional strength is required such as drop hammer piston rods.

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HEPPENSTALL 5 H 50—Heppenstall Co., Pittsburgh. Carbon .5, chrome molybdenum and vanadium alloy furnished as die blocks. Material is heat resistant, abrasion resistant, has high tensile strength and high ductility. Used also for strip mill rolls, etc.

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HERCULOY—Revere Copper & Brass Inc., New York. Silicon-bronze; silicon 3.25, tin .50, balance copper; in addition to properties indicated, it is nonmagnetic; made in sheets, strip, plates, cold drawn rods, shafting, welding rod, forgings, ingot form for sand castings; tensile strength, ult., 120,000 lbs. per sq. in.; weldability, good; brinell hardness, untreated 80; material used for piston rods, shafting, electrical construction, etc.

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HIPERNIK—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. A magnetic alloy consisting of 50 per cent nickel and 49 iron; extremely ductile; developed for special magnetic properties at moderately low induction, primarily for radio applications; also used for transformer laminations; melting point is 1450 degrees Cent.; sometimes used for heater elements for high temperature furnaces with reducing atmospheres.

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HOYT BABBITT METAL—National Lead Co., New York. Analysis according to bearing application.

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HUBBARD SPECIAL—Continental Roll & Steel Foundry Co., East Chicago, Ind. Nickel chrome steel for wear-resisting rolls, guides and miscellaneous castings.

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HYLASTIC—American Steel Foundries, Chicago. Carbon .35, manganese 1.50, vanadium .10-.12, phosphorus and sulphur not over .05; also furnished with the addition of chromium where greater resistance to abrasion is desirable; tensile strength, ult., 95,000 lbs. per sq. in.; used for rolling mill machinery, automotive and railroad equipment, hammer mills and hydraulic machinery.

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HY-SPEED—Buckeye Brass & Mfg. Co., Cleveland. Copper 88, tin 10, lead 2; for bushings, bearings, bars.

See advertisement, Page 12-D

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HYTEMCO—Driver-Harris Co., Harrison, N. J. Alloy of nickel and iron characterized chiefly by its high temperature coefficient of electrical resistance; lends itself advantageously to uses requiring self regulation by temperature such as immersion heaters and heater pads.

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HY-TEN—Wheelock-Lovejoy & Co. Inc., Cambridge, Mass. Chrome-manganese-molybdenum and chrome-nickel-molybdenum alloys with carbon from .10-1; for machine parts.

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IDEALOY—Wellman Bronze & Aluminum Co., Cleveland. Copper-tin-zinc alloy for heavy duty bearings.

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ILLIUM—Burgess-Parr Co., Freeport, Ill.

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G; nickel 58, chromium 22, copper 7, molybdenum 4-6, balance iron, tungsten and manganese; brinell hardness 170-220; for pumps, meters, chemical equipment and other parts subject to corrosion; resists heat to 1500 degrees Fahr.; resists most corrosion solutions except chlorides and other halogens; used for parts subject to corrosion in rayon and chemical industries.

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R; nickel 58, chromium 21-23, copper 0-4, molybdenum 4-6, balance iron, tungsten and manganese; brinell hardness 175-240 annealed, and up to 365 work-hardened; resists most corrosive solutions except those containing chlorides and other halogens; resists heat to 1200 degrees Fahr.; tensile strength 90,000-105,000 lbs. per sq. in. annealed and 140,000-150,000 upon work hardening; used for parts subject to corrosion in rayon and chemical industries.

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INCONEL—The International Nickel Co. Inc., New York. Nickel 79.5, iron 6.5, copper .2, manganese .25, silicon .25, carbon .08, chromium 13, sulphur .015; corrosion resistant, high mechanical properties, resistant to heat up to 2000 degrees Fahr.; used for high temperature applications and equipment for handling food and chemical products.

See advertisement, Page 53-D

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INDUSTRIAL—Industrial Steels Inc., East Cambridge, Mass.

Stainless Steel, No. 35; chrome 13-14, carbon .30-.40. No. 65; chrome 16-17, carbon .60-.70. No. 100; chrome 17-18, carbon .9-1.

Stainless Iron, No. 12; chromium 11.5-13. No. 18; chromium 16-20. No. 512; chromium 11.5-13, .12 carbon, .3-.4 sulphur, balance iron. No. 188; chromium 17-20, nickel 8-10. No. 5188; chromium 17-20, nickel 8-10. No. 188 SMO; chromium 17-20, nickel 8-10, molybdenum 2-4 per cent.

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INGACLAD—Ingersoll Steel & Disc Div., Borg-Warner Corp., Chicago.

Stainless clad steel consisting of a layer of 18-8 chrome nickel, Type 304, also 18-8 columbium stabilized and 18-8 molybdenum bearing, stainless layer bonded to a layer of ordinary steel; uses include equipment for chemical, food, dairy, processing, brewery, packing house, bottling industries, etc.; suitable for applications requiring stainless steel protection on one surface.

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Nickel clad sheets for welding and cold forming; corrosion resistant; medium abrasion resistance; tensile strength 60,000 lbs. per sq. in.; medium ductility; good weldability; used for tanks, hopper, vats, chutes, etc.

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INLAND—Inland Steel Co., Chicago.

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Copper bearing steel; used largely for sheets; copper minimum .20.

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Silico-manganese spring steel.

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Hi-Steel, high strength, high ductility low alloy steel for applications where increased strength and corrosion resistance with decreased weight is desired. A copper-nickel-phosphorus alloy steel.

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IRALITE—Mackintosh-Hemphill Co., Pittsburgh. Alloy iron; specified where sand cast iron could be used except for lack of strength.

1—*Corrosion resistant;* 2—*Heat resistant;* 3—*Abrasion resistant;* 4—*High tensile strength;* 5—*High ductility;* 6—*Bearing application;* 7—*Electrical uses;* 8—*Heat treating;* 9—*Low specific gravity;* 10—*Machinability*

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J & L CORRECT BALANCE (Forging Steel)—Jones & Laughlin Steel Corp., Pittsburgh. Furnished in rough bars or billets, finished rods or bars, and plates, for hot forging. Tensile strength, compressive strength, ductility, weldability, and heat treatments are as specified. Used for any carbon steel parts made from forgings.

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JSB Johnson Bronze Co., New Castle, Pa. Bronze on steel in finished bearings; resists heat to 170 degrees Fahr.; medium abrasion resistance; bearing properties, good; used for bushings, bearings, washers, etc.

See advertisement, Page 9-D

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JALCASE—Jones & Laughlin Steel Corp., Pittsburgh.

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Low carbon open hearth steel which offers machinability practically equivalent to Bessemer screw stock plus the added advantage of rapid case carburizing properties; manufactured as S.A.E. X1314 and S.A.E. X1315 in .10 to .20 carbon grades.

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Open hearth steel which in the higher carbon ranges offers exceptional heat treating qualities combined with forging properties and good machinability; manufactured as S.A.E. X1330 (.25-.35 carbon), S.A.E. X1335 (.30-.40 carbon) and S.A.E. X1340 (.35-.45 carbon).

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JAL-TEN—Jones & Laughlin Steel Corp., Pittsburgh. High tensile steel; especially suitable for machine frame or bin construction; adaptable to hot or cold forming and is easily welded or punched for rivets or bolts; made in standard sections and shapes as specified.

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JESSOP NONMAGNETIC STEEL—Jessop Steel Co., Washington, Pa. Carbon .33, manganese 11, silicon .5, nickel 7.50, sulphur .075 max., phosphorus .075 max.; furnished in rough bars or billets, finished rods or bars, sheets and plates; medium abrasion resistance; tensile strength 80,000-110,000 lbs. per sq. in.; medium ductility; specific gravity 8.02; fair bearing properties; good weldability; brinell hardness, untreated 180, annealed 150; used for transformer covers, controller covers, switch covers, spacing bars, end fingers, etc.

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JOHNSON—Johnson Bronze Co., New Castle, Pa.

No. 27; copper 80, tin 10, lead 10; deoxidized with phosphorus; general purpose bearing bronze.

No. 19; copper 70, tin 11, lead 19; high wear rating and resistance to pounding; for mill bearings, gas and diesel engines, excavating and pulverizing machinery, etc.

No. 25 (plastic bronze); copper 75, tin 5, lead 19, nickel 1; for high speed with light to medium loads and generally free from shock; because it has good acid resistance it is particularly suitable for pump bearings and sleeves, and also for electric motor, conveyor and fan, and woodworking machinery bearings.

No. 29; copper 78, tin 7, lead 15; for use where spindle is of soft steel and speed is relatively high; acid resisting alloy.

No. 53; copper 88, tin 10, zinc 2; for severe service or heavy pressures; should be used where shaft is hardened steel and well lubricated.

No. 72; copper 83, tin 7, lead 7, zinc 3; best suited for moderate speeds and low loads.

No. 10 (babbitt alloy); tin 90, antimony 5, copper 5; for thin linings and also may be used in die castings.

No. 11; tin 87, antimony 7, copper 6; rather hard babbitt recommended as lining for connecting rods and shaft bearings subjected to heavy pressures.

No. 12; tin 90, antimony 7.5, copper 2.5; for high speeds and high temperatures.

See advertisement, Page 9-D

K

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K-42-B—Westinghouse Electric & Mfg. Co., East Pittsburgh. Nickel 45, cobalt 25, iron 8, chromium 20, titanium 2; furnished in rough bars or billets, rods or bars, wire, strips (coiled), and plates; for hot forging, stamping, turning, boring, welding, etc., also furnished as sand castings; resists corrosion caused by atmosphere and salt solutions; resists heat to 2000 degrees Fahr.; tensile strength, ult., 160,000 lbs. per sq. in.; nonmagnetic; brinell hardness, heat-treated 300-400; for applications where corrosion resistance, heat resistance, high strength at high temperatures are required.

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KENNAMETAL—McKenna Metals Co., Latrobe, Pa.

Type KWH; Cobalt 11, tungsten, tungsten-titanium, carbide, columbium carbide constituting balance; corrosion resistant, resists heat to 1200 degrees Fahr., high abrasion resistance; tensile strength (transverse rupture test) 220,000 lbs. per sq. in.; compressive strength 680,000 lbs. per sq. in.; specific gravity 10.5; good magnetic and bearing properties; for wear resisting guides, valves, nozzles, etc.

See advertisement, Page 75-D

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KLEENKUT—Heppenstall Co., Pittsburgh. Tool steel containing 2 carbon and 12 per cent chromium; for shear knives for cold shearing light material.

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KONAL—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Nickel 72, cobalt 17, titanium 2.2, iron 6.25; internal combustion engine valves, molds and machine parts subject to stress at high temperatures.

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KOVAR—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Low expansion to 400 degrees Cent.; approximately 28.2 nickel, 18 cobalt, 53.8 iron; for gas-tight metal-to-glass seals on radio tubes and similar applications. Distributed by Stupakoff Laboratories, Pittsburgh.

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KROKOLOY—Detroit Alloy Steel Co., Detroit. Furnished in castings, chromium 12-14, carbon 1.5-1.6, cobalt 3-3.5, molybdenum .85-.90. Semiresistant to corrosion; heat to 1000 degrees Fahr.; abrasion resistance, high; tensile strength, ult., 125,000 lbs. per sq. in.; compressive strength, ult., 400,000 lbs. per sq. in.; medium ductility; good bearing and magnetic properties; used for high-speed bearings and cams, valve seats, etc.

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LEDALOYL—Johnson Bronze Co., New Castle, Pa. Self-lubricating bearing bronze, pre-alloyed; contains lead which eliminates harshness and provides conformability for misalignment; combination of lead and graphite plus oil content make it useful where lubrication is remote or likely to be forgotten.

See advertisement, Page 9-D

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LEDLOY STEELS 10—Inland Steel Co., Chicago. Lead-bearing, free-cutting, open-hearth steel; contains about one-quarter per cent lead, which increases machinability about 30-50 per cent and tool life approximately 50-200 per cent, but has no appreciable adverse effect on physical properties of the steel.

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LIGHTWELD—Lincoln Electric Co., Cleveland. Arc welding electrode made for fabrication of chain and gear guards and other machine parts of light gage steel.

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LO CRO 46 — Crucible Steel Co. of America, New York. The following grades are used where high strength at elevated temperatures to 1200 degrees Fahr. is required.

Type 46; chromium 5.

Type 46MO; chromium 5, molybdenum .50.

Type 46 W; chromium 5, tungsten 1.

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LOTUS BABBITT—Lumen Bearing Co., Buffalo. Lead base bearing babbitt.

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LUBRICO—Buckeye Brass & Mfg. Co., Cleveland. Copper 75, lead 20, tin 5 per cent; for bearings, bushings and bars.

See advertisement, Page 12-D

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LUKENS—Lukens Steel Co., Coatesville, Pa.

2 per cent nickel steel; furnished in sheets, plates and spun and pressed heads; for hot forging, stamping, welding, riveting, turning, boring, etc., into many types of machine parts where a high-tensile steel of good ductility is required.

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Carbon-Molybdenum steel; furnished in sheets, plates and spun and pressed heads for hot forging, stamping, welding, riveting, turning, boring, etc.; for machine parts requiring a high-strength steel which retains its strength under conditions of elevated temperature operation.

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Abrasion resisting steel; furnished same as above, for use in a variety of parts requiring resistance to wear or abrasion.

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Gear rim steel; furnished same as above; abrasion and wear resisting; originally developed for use in rims of welded gear blanks, as well as other machine parts.

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Chrome-manganese steel; furnished same as above; tensile strength 100,000 lbs. per sq. in.; used principally in fan blades and fan rings.

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Chrome-copper-nickel steel; furnished same as above; tensile strength 65,000 lbs. per sq. in.; used where good resistance to impact is desired in parts operating in sub-zero temperatures.

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Manganese-vanadium steel; furnished in same as foregoing; high tensile steel with good welding properties, used in construction of antiaircraft gun mounts and carriages as well as military tank parts.

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Manganese-molybdenum steel; furnished same as foregoing; tensile strength 95,000 lbs. per sq. in.; for use in parts in which abrasion and high tensile strength is desirable.

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Nickel-clad, Super nickel-clad, Inconel-clad and Monel-clad steels are all clad metals or bi-metals consisting of light layer of corrosion resistant super-nickel, nickel, Inconel or Monel bonded to a heavier base plate of steel. All are corrosion resistant and are used in variety of machine parts where this property is desirable.

1 2 - 4 5 6 7 8 9 -

LUMEN ALLOYS—Lumen Bearing Co., Buffalo. (Note: "Lumen Alloy," together with each of the following numbers and grades, is a copyrighted term which should be used in specifying these materials. Thus, "Lumen Alloy No. OOA," etc.)

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Nos. 00A and 00C; high tin bronzes for high compression bearing applications.

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No. 1; zinc bronze for pressure castings including spur and bevel gears mating with steel.

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No. 2; zinc bronze for machine parts, bearings, etc.

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No. 3; zinc bronze for mine service and paper mill machinery and bearings.

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No. 4; phosphor bronze (leaded), for bearings.

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No. 4 chill cast; for heavy duty bearings, etc.

No. 4A; high phosphorus bronze (leaded), for bearings on hard steel.

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No. 5; general service casting alloy; red brass; for low pressure valve bodies, etc.

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No. 7; phosphor bronze; uses include trolley wheels and castings to be nickel or chromium plated.

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No. 9; maganese bronze for machine parts requiring strength, electrical conductivity, and high pressure.

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No. 11-C; (sand cast) aluminum bronze; for miter, bevel gears and bearings subject to impact.

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No. 11-C; (heat treated) tensile strength 65,000-100,000 lbs. per sq. in.; recommended where strength, corrosion and heat resistance are required.

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No. 14; zinc bronze, babbitt backing; for valve bodies, etc.

1—Corrosion resistant; 2—Heat resistant; 3—Abrasion resistant; 4—High tensile strength; 5—High ductility; 6—Bearing application; 7—Electrical uses; 8—Heat treating; 9—Low specific gravity; 10—Machinability

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No. 15; phosphor bronze; for worm wheels, bearings, etc.

No. 15 chill cast; for worm gears, nuts and bearings.

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No. 15A; phosphor bronze (slightly leaded); for worm wheels, bearings, etc.

No. 15-A chill cast; for heavy duty bearings and worm gear castings.

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No. 20; super-manganese bronze; for machine parts requiring extra strength.

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No. 27; (sand cast) aluminum bronze; for strength and corrosion resistance.

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No. 27; (heat treated) for extreme tensile strength and shock resistance.

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No. 31; for high-speed, low-duty bearings.

No. 33; for bearings, high speed, low duty.

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No. 43; nickel tin bronze for bearings, worm gears and nuts; abrasion resistant.

No. 43 (Chilled); nickel tin bronze for bearings, worm gears and nuts with higher tensile strength than No. 43.

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No. 48; nickel phosphor bronze; for bearings used with hardened steel, worm wheels, etc.

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No. 48 chill cast; for bearings, worm gears, nuts, slippers, etc.

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No. 54; phosphor bronze (leaded) for bearings and worm wheels for intermediate service.

No. 54 chill cast; for bearings, worm gears, nuts, etc.

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Old Genuine Babbitt; high strength ingot babbitt for bearings.

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Cosmo Babbitt; ingot material for bearings.

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Bronze; a zinc base alloy for bearings.

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LYNITE—Aluminum Co. of America, Pittsburgh. Aluminum wrought and casting alloys in the following grades: Nos. 43, 112, 113, 195, B195, 356, 14S, and A51S. Additional information on each of these grades will be found in listing ALCOA under the specific grade number.

See advertisement, Page 13-D

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MACHEMPITE "Wearprooft" — Macintosh-Hemphill Co., Pittsburgh. Alloy cast, forged or rolled steel; for gears, locomotive guides, track wheels, sprockets, conveyor parts, etc. Also MacHempite processing rolls for plastics industry.

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MACHINEBRONZE—Lumen Bearing Co., Buffalo. Zinc bronze; cored and solid bars for bearings.

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MAGNOLIA—Magnolia Metal Co., Elizabeth, N. J.

Antifriction metal; lead-tin-antimony plus special fluxes, furnished in ingots; tensile strength, ult., 15,000 lbs. per sq. in.; compressive strength, ult., 20,650 lbs. per sq. in.; bearing properties, good; brinell hardness, untreated 21.8; used for bearings.

Isotropic Die Cast bronze bar stock; copper 80, tin 10, lead 10, and other alloys to suit conditions; furnished in cored bars; resists corrosion caused by acids; resists heat to 900 degrees Fahr.; tensile strength, ult., 31,500 lbs. per sq. in.; compressive strength, ult., 15,000 lbs. per sq. in.; bearing properties, good; brinell hardness, untreated 70; used for bearings.

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MALLIX—National Malleable & Steel Castings Co., Cleveland. Pearlitic malleable iron; tensile strength 75,000 lbs. per sq. in., elongation 5 per cent; for grate bars for sintering machines, elevator buckets, screen plates for pan mills and other castings subjected to heat, abrasion and shock.

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MALLORY—P. R. Mallory & Co. Inc., Indianapolis.

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3 Metal: a copper-chromium-lithium alloy; used extensively for spot, flash and seam welding cold-rolled steel, stainless steel, nickel alloys and Monel metal, silicon bronze alloys, zinc, nickel, silver and other materials employed in applications where a high strength, high conductivity material is required.

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53Z Metal; copper base alloy furnished in castings only; tensile strength 60,000-70,000 lbs. per sq. in.; used for heavy-duty butt seam welding wheels, flash welding dies, bearings and current and heat-carrying members in electrical and other machinery.

73 Metal; rough and finished bars and sheets containing 95 per cent copper; resists sea water; 160,000-200,000 lbs. per sq. in. tensile strength; used for bearings and bushings, vibrator arms, springs, spring washers and electrodes for projection welding.

100 Metal; rough and finished bars containing 95 per cent copper; recommended for high loaded small gears, current-carrying bearings, springs and other details.

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22 Metal; Copper-cadmium-zirconium alloy; furnished in finished rods or bars for hot forging, extruding, turning, boring, etc.; resists heat to 840 degrees Fahr.; high abrasion resistance; tensile strength, 75,000 lbs. per sq. in.; high ductility, good bearing properties; for welding tips, wheels, etc.

84 Metal; Copper 95; furnished in finished rods or bars and sheets for hot forging, extruding, turning, boring, etc.; resists heat to 1110 degrees Fahr.: high abrasion resistance; tensile strength 100,000 lbs. per sq. in.; high ductility; brinell hardness, heat treated 210; for soldering iron tips, small gears (highly loaded) electrodes for spot and seam welding materials of high electrical resistance such as Monel, stainless steel, etc.

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MANDENSITE—American Manganese Steel Div., The American Brake Shoe & Foundry Co., Chicago Heights, Ill. A special alloy of manganese steel, having 10-14 manganese, 1-1.4 carbon, and substantial chromium content.

See advertisement, Page 67-D

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MANGANWELD—Lincoln Electric Co., Cleveland. Arc welding electrode that produces deposit of austenitic manganese-nickel-molybdenum steel; suitable for hard facing austenitic manganese steel parts containing 11-14 per cent manganese, such as crusher parts, valves, turbine runners, pulverizer roll shafts, gathering and loading equipment.

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MARTIN STEEL—Detroit Alloy Steel Co., Detroit. Furnished as castings. Chromium 12-14, carbon 1.5-1.6, cobalt 1.25, molybenum 1.25; semiresistant; resists heat to 1000 degrees Fahr.; high abrasion resistance; tensile strength, ult., 115,000 lbs. per sq. in.; compressive strength, ult., 375,000 lbs. per sq. in.; medium ductility; good bearing and magnetic properties; brinell hardness, untreated 220, heat treated 600; for use as high speed bearings, cams, valve seats, spindles, etc.

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MASSILLON—Massillon Steel Casting Co., Massillon, O. Alloy cast steel, heat treated; for domestic, industrial and locomotive stoker worms.

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MAURATH—Maurath Inc., Cleveland. Alloy welding rods of many types; each type made especially for use with one of the leading varieties of stainless and heat-resisting steels and with coating of distinctive identifying color, also uncoated electrodes and those of special analyses.

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MAX-EL—Crucible Steel Co. of America, New York.

1-B; carbon .20, with high manganese and low molybdenum; excellent machining and uniformity in carburizing response; used for automobile parts, machine tool parts, gages, sprockets, etc.

2-B; carbon .40, manganese 1; used in "as rolled" condition for machine tool spindles, lead screws, racks, worms, piston rods, etc.

3½ for heat treated parts on machine tools, such as gears, arbors, spindles, etc.

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MAYARI—Bethlehem Steel Co. Inc., Bethlehem, Pa.

A; a nickel-chromium series of steels, corresponding to S.A.E. 31 XX series, suitable for heat-treated parts. Furnished in various carbon ranges for carburizing, water and oil-hardened parts.

B; a nickel-chromium steel furnished as bolts and sucker rods, having good atmospheric corrosion resistance combined with moderate strength, used in heat-treated condition.

R; a low-carbon, high-strength nickel-chromium-copper-phosphorus structural steel having good resistance to atmospheric corrosion. Used for structural purposes where weight reduction and corrosion resistance are desired.

XI; a nickel-chromium-vanadium steel furnished as sucker rods and having properties similar to Mayari B but having higher tensile strength and yield point with same ductility. Responds readily to normalizing without internal stresses.

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MAZLO Magnesium Alloys—American Magnesium Corp., Cleveland. Characteristics are light weight with mechanical strength and excellent machinability (2/3 that of aluminum); alkali resistant.

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No. AM 240; 90 magnesium, 10 aluminum; furnished as sand castings; for parts of portable equipment and moving machinery where light weight and high strength is important.

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No. AM 260; available as sand castings; aluminum 9, zinc 1, balance magnesium; corrosion resistant; high tensile strength; low specific gravity; lightweight; machinability; for use as part that must be portable or moved at high speeds.

No. AM 265; 6 aluminum, 3 zinc, balance magnesium; furnished as sand castings; for parts of portable and moving machinery.

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No. AM 230; 10 aluminum, .5 silicon, balance magnesium; furnished as die castings; for moving parts and portable equipment.

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No. AM 57S; 6 aluminum, 1 zinc, balance magnesium; for use in the form of rods and tubes and for machinery where light weight is important.

No. AM 3S; 1.2 manganese, balance magnesium; furnished in sheets suitable for welding; for aircraft parts such as oil tanks, fuselage partitions and cowlings.

No. AM 58S; 8 aluminum, 1 zinc, balance magnesium; supplied as hot press forgings for parts under stress where lightness is important as in aircraft engine parts.

No. AM 65S; 3.5 aluminum, 5 tin, balance magnesium; for hot forged, stressed parts where light weight is important.

See advertisement, Page 4-D

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McGILL—McGill Mfg. Co., Valparaiso, Ind.

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No. 1 McGill Metal; aluminum bronze alloy, suitable for pump liners, gears, corrosion resistant castings and parts requiring strength, toughness with minimum weight.

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No. 2: McGill silicon bronze; corrosion resistant; resists heat to 500 degrees Fahr.; medium abrasion resistance; tensile strength 95,000 lbs. per sq. in.; brinell hardness, untreated 160-180.

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No. 4 McGill bronze hydraulic pressure castings; finished casting tolerance of plus or minus .005.

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MEEHANITE—Meehanite Metal Corp., Pittsburgh, and licensees as listed hereunder. A sorbo-pearlitic iron containing silicon, manganese, phosphorus, sulphur and carbon, composition depending upon mixture and physical constitution as determined by service requirements; twenty-five grades, some of which can be heat treated, and flame hardened, each having a separate and distinct combination of physical properties; available in cast form; for machinery and miscellaneous castings.

Licensees include the following: American Brake Shoe & Fdy. Co., Mahwah, N. J.; Banner Iron Works, St. Louis; H. W. Butterworth & Sons Co., Bethayeres, Pa.; M. H. Detrick Co., Newark, N. J.; Farrel Birmingham Co., Ansonia, Conn.; Fleming Foundry Co., Springfield, Mass.; E. Long Ltd., Orillia, Ont.; General Electric Co., Ontario, Calif.; Valley Iron Works Inc., St. Paul; Greenlee Foundry Co., Chicago;

1—*Corrosion resistant;* 2—*Heat resistant;* 3—*Abrasion resistant;* 4—*High tensile strength;* 5—*High ductility;* 6—*Bearing application;* 7—*Electrical uses;* 8—*Heat treating;* 9—*Low specific gravity;* 10—*Machinability*

American Laundry Machinery Co., Rochester, N. Y.; Cincinnati Milling Machine Co., Cincinnati; Cooper Bessemer Corp., Grove City, Pa., and Mt. Vernon, O.; Crawford & Doherty Foundry Co., Portland, Oreg.; Florence Pipe Foundry & Machine Co., Florence, N. J.; The Newark Stove Co., Newark, O.; Fulton Foundry & Machine Co. Inc., Cleveland; General Foundry Mfg. Co., Flint, Mich.; Stearns-Roger Mfg. Co., Denver, Colo.; Hamilton Foundry & Machine Co., Hamilton, O.; Kanawha Mfg. Co., Charleston, W. Va.; Barnett Foundry & Machine Co., Irvington, N. J.; Henry Perkins Co., Bridgewater, Mass.; Pohlman Foundry Co., Buffalo, N. Y.; Rosedale Foundry & Machine Co., Pittsburgh; Warren Foundry & Pipe Corp., Phillipsburg, N. J.; Kinney Iron Works, Los Angeles; Koehring Co., Milwaukee; Marshall Stove Co., Lewisburg, Tenn.; Vulcan Foundry Co., Oakland, Calif.; Atlas Foundry Co., Detroit; Ross-Meehan Foundries, Chattanooga, Tenn.; Vancouver Engrg. Works, Vancouver, B. C.; Washington Iron Works, Seattle; Washington Machinery & Supply Co., Spokane, Wash.

See advertisement, Page 79-D

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METALINE—R. W. Rhoades Metaline Co. Inc., Long Island City, N. Y. Lubricating insert plugs of several diameters and lengths and in varied compositions for rendering bronze bearings and bushings oilless. Also bronze bearings complete in which Metaline plugs are inserted, furnished in form of finished bearings.

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MILL BRASS MIX—F. A. Williams & Son Inc., Jersey City, N. J. Bearings, bushings and mill brasses.

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MOGUL BABBITT—Federal-Mogul Corp., Detroit.

Mogul alloy genuine babbitt; made from tin, antimony and copper, virtually lead free; hard tough alloy; high tensile strength; suitable for die-cast and hand-poured bearings; used for high-speed automobile and aircraft engine, steel and bronze back main and connecting-rod bearings, trucks, tractors, high-speed machinery, planers, and crossheads.

Mogul bearing metal; general all-purpose babbitt for repair and maintenance; for bearings requiring toughness; used for machinery bearings, stationary gas engines, paper mill, rolling mill, rubber plant and brick machinery.

407 nickel babbitt; varying slightly from Mogul genuine babbitt alloy; for applications where speed is fairly high and bearings are large, that is 1/16th-inch or more in thickness; used in woodworking machinery and other heavy duty types.

408 special babbitt (copper hardened); originally produced for electric railway armatures, now used for special bearing applications; has great durability and will stand up under hard wear; used in motor pumps, motor shafts, rock crushers and forming presses.

Duro antifriction metal; while softer and less tough than Mogul bearing metal (above), compares favorably with lead base general purpose babbitts; used for flour mill, laundry, canning and bottling machinery, pump packing, slow moving pullys and axle bearings.

Special "B"; a lead and antimony alloy; free of usual nonbearing ingredients; used for slow speed bearings of all kinds and heavy line shafting.

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MO-LYB-DEN-UM—Climax Molybdenum Co., New York. An alloying element for use in steel and iron; imparts strength, toughness, ductility and resistance to abrasion; improves fatigue value, eliminates temper embrittlement, increases physical properties at elevated temperatures; molybdenum steel is easily welded and machined.

See advertisement, Page 63-D

- 2 3 4 - - - - - -

MO-MAX—The Cleveland Twist Drill Co., Cleveland. A high speed steel, furnished in rough bars or billets, finished rods or bars, wire and sheets, for hot forging, turning, boring, welding, etc.; resists heat up to 1100 degrees Fahr.; high abrasion resistance; high tensile strength; good bearing properties; specific gravity about 7.95; good weldability; brinell hardness, untreated 220, heat treated 700; for use where great strength and wear resistance up to temperatures of 1000 degrees Fahr. are required such as gears, cams, guides, wearing plates, etc.

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MONEL—The International Nickel Co. Inc., New York. Nickel 67, copper 30, iron 1.4, manganese 1, silicon .1, carbon .15, sulphur .01; general purpose corrosion resistant, high strength, rustproof alloy; used for applications requiring protection against chemical reaction, high mechanical properties or attractive appearance.

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K Monel; Nickel 66, copper 29, iron .9, manganese .4, silicon .25, carbon .15, sulphur .005, aluminum 2.75; heat treatable alloy affording corrosion and abrasion resistance plus mechanical properties comparable to those of heat-treated alloy steels; nonmagnetic; for parts requiring corrosion resistance with high mechanical or nonmagnetic properties.

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R Monel; Nickel 67, copper 30, iron 1.7, manganese 1.1, silicon .05, carbon .1, sulphur .035; for parts requiring corrosion and abrasion resistance combined with free-cutting qualities permitting high-speed automatic machine work.

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S Monel; Nickel 63, copper 30, iron 2, manganese .9, silicon 4, carbon .1, sulpur .015; high-strength, corrosion and abrasion resistant material for castings requiring extra hardness for resistance of galling and seizing.

See advertisement, Page 53-D

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MORAINE—Moraine Products Div., General Motors Corp., Dayton, O. Rolled bronze split-type bearings and bushings for automobiles, electric motors and farm implements.

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MORGANITE—Morganite Brush Co. Inc., Long Island City, N. Y. Carbon-graphite, and carbon-graphite-metal mixtures; furnished in finished rods or bars and plates, for turning, boring, molding, etc.; resists corrosion caused by any liquid handled industrially; resists heat to 700 degrees Fahr.; good abrasion resistance; tensile strength, ult., 1000-3000 lbs. per sq. in.; compressive strength, ult., 10,000-30,000 lbs. per sq. in.; ductility, low; specific gravity 2-2.15; used for bearings, valves, seals, nonfriction slides, piston rings, etc.

See advertisement, Page 73-D

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MUELLER 600 BRONZE—Mueller Brass Co., Port Huron, Mich. Copper 60, zinc 35, other ingredients 5. Bearing alloy for worm gears, connecting rods, seal rings for refrigerators, crankshafts for oil pumps, etc. Has high strength and corrosion resistance, especially resistant to sulphur compounds.

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MUMETAL—Allegheny Ludlum Steel Corp., Pittsburgh. Furnished in sheets, coiled strips and laminations for stamping, forming and drawing. Nickel 7.1-7.6, copper 4.5-6, chromium 2 max., balance iron. Has high permeability qualities; recommended heat treatment, 1800-2000 degrees Fahr.; used for audio-transformers, sensitive relays and electrical instruments.

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MUREX—Metal & Thermit Corp., New York A series of welding electrodes designed for welding mild steel carbon-molybdenum steel U.S.S. Cor-Ten and Mayari, Cromansil, nickel steels, chrome-molybdenum, chrome-nickel, straight chrome, manganese, and high carbon steels and for building up and hard surfacing.

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N-A-X HIGH TENSILE—Great Lakes Steel Corp., Div. of National Steel Corp., Ecorse, Detroit. Carbon .10-.18, manganese .60-.75, silicon .65-.9, copper .25 max., chromium .5-.65, nickel .1-.25, molybdenum .15 max., zirconium .1-.15, sulphur .04 max., phosphorus .04 max.; furnished in rough bars or billets, finished rods or bars, sheets, strips and plates; corrosion resistant; resists heat to 700 degrees Fahr.; medium abrasion resistance; tensile strength 75,000-85,000 lbs. per sq. in.; high ductility; good bearing properties and weldability; brinell hardness, untreated 149-156, heat treated 230-375; used for machine parts where high torsional properties, high tensile strength and resistance to fatigue and notch impact at normal and sub-zero temperatures are required.

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NA, NA-1, NA-2—National Alloy Steel Division, Blawnox, Pa. Varying percentages of nickel and chromium.

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NACO—National Malleable & Steel Castings Co., Cleveland. Specially processed cast steel; for service where heavy blows and constant friction require a material that combines great strength, toughness and resistance to wear; used in chains for steam shovel, dragline, draft gears, railway equipment.

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NELOY—National-Erie Corp., Erie, Pa. Steel castings, rough, finished, machined or flame hardened; high strength and hardness due to combination of alloying and special hardening; high abrasion resistance. Used for various applications in rolling mills and steel works equipment, overhead traveling cranes, power shovels, drag lines, and other heavy machinery.

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NICHROME—Driver-Harris Co., Harrison, N. J. Acid and alkali, heat resistant alloy consisting of nickel 60, iron 25, chromium 15; resists heat to 2000 degrees Fahr.; recommended for furnace parts, acid dipping baskets, and filter screen.

A; nickel 62, chromium 15; heating element material; also for electrical devices including rheostats, potentiometers, seamless tubing, etc.

B; as an addition to cast iron; sold in ratios of 5 and 2½ parts of nickel to 1 part of chromium.

V; nickel 80, chromium 20; heating element material; also in sheets for welded tubing.

Cast Nichrome; for furnace parts, pyrometer protection tubes, conveyor castings and carburizing containers. Sheet Nichrome S; sheet; nickel 27, chromium 15, used for various applications.

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NICKEL—International Nickel Co. Inc., New York.

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Nickel; Nickel 99.4, copper .1, iron .15, manganese .2, silicon .05, carbon .1, sulphur .005; rustproof, corrosion-resistant chemical parts and where corrosion resistance is desired.

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D Nickel; Nickel 95.2, copper .05, iron .15, manganese 4.5, silicon .05, carbon .1, sulphur .005, a metal similar to nickel but affording superior mechanical properties and resistance to atmospheric attack at elevated temperatures.

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Z Nickel; Nickel 98; heat treatable material resembling nickel except for its higher mechanical properties which are comparable to those of oil-tempered spring steel; used for products requiring spring properties coupled with corrosion resistance.

See advertisement, Page 53-D

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NICKELCHROMEWELD—Lincoln Electric Co., Cleveland. Heavily coated electrode of shielded arc type for welding of Inconel, Nichrome and other similar alloys of 70-80 per cent nickel, 11-15 per cent chromium and 5-10 per cent iron.

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NICKELOID—American Nickeloid Co., Peru, Ill., Nickel bonded to zinc, latter serving as rustproof, flexible and inexpensive white metal base. Available in variety of brilliant finishes and patterns, as sheets, flat strips and coiled strip for continuous feed automatic presses. Can be supplied with quick removable, gum-adhered paper covering permitting drawing and forming without marring pre-finish. For tube clips, toys, automotive details and stamped and formed parts demanding bright, permanent finish.

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NICUITE—A. W. Cadman Mfg. Co., Pittsburgh. Nickel bronze; tin 10, nickel 3.5, zinc 2.5, trace of phosphorus, balance copper; high compressive strength for slow or medium speed operation under extreme pressures.

1—*Corrosion resistant;* **2**—*Heat resistant;* **3**—*Abrasion resistant;* **4**—*High tensile strength;* **5**—*High ductility;* **6**—*Bearing application;* **7**—*Electrical uses;* **8**—*Heat treating;* **9**—*Low specific gravity;* **10**—*Machinability*

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NI-HARD—International Nickel Co. Inc., New York, and licensees. Nickel 4.5, chromium 1.5, total carbon 2.7-3.6; cast iron for chilled rolls, grinding balls, mill liners, etc., where abrasion is encountered.

See advertisement, Page 53-D

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NILVAR—Driver-Harris Co., Harrison. N. J. A 36 per cent nickel steel having the lowest coefficient of expansion to 392 degrees Fahr. of an alloy; used for thermostatic controls in heating apparatus such as electric ovens, laboratory ovens, gas ovens, oil burners, and house heating apparatus.

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NIPERMAG—Cinaudagraph Corp., Stamford, Conn. Nickel-aluminum-iron alloy furnished as sand castings; resists corrosion; specific gravity, 7; fair weldability; hardness on Rockwell C scale from 48-53, variable on account of crystal structure; for permanent magnets only.

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NI-RESIST—International Nickel Co. Inc., New York and licensees. Nickel 14, copper 6, chromium 2, total carbon 2.60-3.10, silicon 1.25-2, manganese 1-1.5; for castings handling corrosive waters and other solutions, or heats above the range of temperature where ordinary cast iron gives good service; resists corrosive vapors, gases and liquids; recommended instead of plain cast iron under such conditions.

See advertisement, Page 53-D

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NIREX—Driver-Harris Co., Harrison, N. J. Acid-resisting material with tensile strength, annealed, up to 95,000 lbs. per sq. in.; spring temper 180,000; supplied in finished rods or bars, wire, sheets and strip; also can be fabricated by sand casting; for use where corrosion and heat resistance, and spring properties will be useful.

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NI-TENSYLIRON—International Nickel Co. Inc., New York, and licensees. Nickel 1-4, total carbon 2.50-3.15, silicon 1.20-2.75, manganese .5-.9; for machine tool castings, diesel engine housings, auto cylinder blocks, pistons, etc.

See advertisement, Page 53-D

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NITRALLOY—Nitralloy Corp., New York, controls nitriding process and licenses under which alloy is produced. A chromium-molybdenum-aluminum steel capable of developing extreme hardness through nitriding; for cams and camshafts, gears, pump parts, splined shafts, cylinder liners, etc. Licensees include Bethlehem Steel Co., Crucible Steel Co. of America, Firth-Sterling Steel Co., Allegheny Ludlum Steel Corp., Vanadium-Alloys Steel Co., Republic Steel Corp., Lebanon Steel Foundry, Empire Steel Castings Co., Milwaukee Steel Foundry Co., Timken Roller Bearing Co.

See advertisement, Pages 6-D, 7-D

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NUREX—National Malleable & Steel Castings Co., Cleveland. A chromium-manganese-carbon alloy furnished in castings; resists corrosion caused by dilute aqueous solutions and acids (except phosphoric); resists heat to 1700 degrees Fahr.; abrasion resistance, high; ductility, low; used for mill balls, lining and similar purposes.

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OFHC—Scomet Engineering Co. (subsidiary of The American Metal Co. Ltd.), New York. Copper 99.985 per cent, oxygen free; furnished in rough bars or billets; resists heat to 1500 degrees Fahr.; medium abrasion resistance; tensile strength 65,000 lbs. per sq. in.; high ductility; specific gravity 8.93; excellent electric properties; brinell hardness, untreated 30-120. Used for electrical conductors of all kinds, tubing, strips, plates.

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OHMALOY—Allegheny Ludlum Steel Corp., Pittsburgh. Furnished in sheets, coiled strip, wire and rods, for stamping, turning and boring. Chromium 12-14, aluminum 4-4.75, balance iron. Has high electrical resistivity; magnetic properties moderate; resists oxidation to 1600 degrees Fahr. Anneals at 1350-1450 degrees Fahr. Used for electrical resistor grids and wire wound resistors, also edge-wound strip resistor.

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OILITE—Chrysler Corp. Amplex Div., Detroit, Mich. Oil cushion, heavy-duty bronze bearings containing one-third oil by volume; used extensively in automobiles, airplanes, farm implements, textile machinery, conveyors, air conditioners, machine tools, household equipment, electric motors, pumps, special machinery, clocks, etc.

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OLYMPIC BRONZE—Chase Brass & Copper Co., Waterbury, Conn.

Type A; copper 96, silicon 3, zinc 1; tensile strength, 55,000-150,000 lbs. per sq. in.; brinell hardness 70-200; annealed at 1100-1200 degrees Fahr. if necessary to soften for additional cold working; resists corrosion due to saline, acid and alkaline solutions; used for welded structural parts, bolts, nuts, tubing, tie rods, etc.

Type B; copper 97.5, silicon 1.5, zinc 1; tensile strength, 45,000-90,000 lbs. per sq. in.; annealed at 1100-1200 degrees Fahr. if necessary to soften for additional cold working; resists corrosion due to saline, acid and alkaline solutions; used for bolts, nuts, pipe and tubing.

Type C; copper 94.75, silicon 4.25, zinc 1; for sand castings; tensile strength, 40,000-50,000 lbs. per sq. in.; brinell hardness 85; resists corrosion due to saline acid and alkaline solutions; used for corrosion resistant casting.

Type D; copper 95.6, silicon 3.0, zinc 1, lead .4; physical properties same as type "A"; a free-machining alloy recommended for bolts, nuts and screw machine parts.

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OREIDE—Scovill Mfg. Co., Waterbury, Conn. Copper 90, tin .5, balance zinc; furnished in finished rods or bars, tubing, wire, sheets and strips (coiled); for stamping, turning, boring, etc., into machine parts; medium abrasion resistance; tensile strength, 95,000 lbs. per sq. in. (hard drawn or rolled); specific gravity, 8.8; bearing properties fair; electrical properties fair; recommended heat treatments, anneal at 975-1025 degrees Fahr.; spring properties good; used primarily for spring contacts and switch parts.

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OXWELD—Linde Air Products Co., New York.

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No. 1; welding rod for steel giving welds of high tensile strengths up to 70,000 lbs. per sq. in.

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No. 7; drawn iron welding rod giving welds where high tensile strength is not a factor.

No. 9; cast iron rod (square) for gray iron castings.

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No. 23; welding rod for cast aluminum and aluminum alloys, giving high tensile strength.

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No. 25M; bronze welding rod having brinell hardness of 96 and high tensile strength.

No. 28; a columbium bearing welding rod suitable for 18-8 stainless steel.

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PDCP COPPER (Oxygen free)—Phelps Dodge Copper Products Corp., New York. Copper 99.98; furnished in finished rods or bars, tubing, wire and strip; for hot forging, stamping, extruding, turning, boring, welding, drawing, etc.; resists heat to 406 degrees Fahr.; tensile strength 33,000-60,000 lbs. per sq. in.; high ductility; for bus bar, distiller tubes, water tubing, magnet wire, bull ring wire, strip for forming, stamping, etc.

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PMG METAL—Phelps Dodge Copper Products Corp., New York. High-tensile silicon bronze having high strength and hardness, low coefficient of friction, resistance to impact, etc.; produced in form of rods, wire, tubing, strip, sheet, sand castings, die castings and centrifugal castings; used for pump shafting, rods, bolts, nuts and rivets, valve parts, gears, bearings, spindles and rigid conduit and electrical metallic tubing.

PAINTGRIP—American Rolling Mill Co., Middletown, O. Galvanized sheet iron or steel with special bonderized surface integral with zinc coating; for immediate painting after fabrication. Obviates acid etching or weathering. Phosphate film neutral to paint and extends paint life, greatly retarding flaking and peeling.

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PERDURO—The Jeffrey Mfg. Co., Columbus, O. High-strength malleable iron for sand casting; resists corrosion due to analysis and heat treatment; resists heat to 1100 degrees Fahr.; high abrasion resistance; tensile strength, 80,000 lbs. per sq. in.; used for cast chains for drive and conveyor service.

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PERMITE—Aluminum Industries Inc., Cincinnati. Following grades available as sand castings, gravity die castings and ingots.

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No. 1002; copper 10, iron 1.50, magnesium 40, balance aluminum; for pistons for automotive, pump and refrigeration service.

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No. 1010; copper 4, silicon 1, balance aluminum; for machine parts to resist shock; heat treatment is to soak at critical and quench in water, and reheat at 350 degrees Fahr. to desired properties.

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No. 1019; furnished in ingots and sand castings; silicon 5, copper 1.25, magnesium .50, balance aluminum; heat treatment, quenching in water; suitable for highly stressed parts including airplane engine parts.

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No. 2011; silicon 5, balance aluminum; for parts subject to atmospheric corrosion.

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No. 2021; magnesium 4, balance aluminum; for parts subject to salt water corrosion.

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PHELPS—Phelps Dodge Copper Products Corp., New York.

Aluminum Brass (Bulldog Brand); copper 76, tin 22, aluminum 2; furnished in tubing for extruding, welding and drawing; corrosion resistant; resists heat to 406 degrees Fahr.; tensile strength 50,000-100,000 lbs. per sq. in.; high ductility; for condenser tubes.

Arsenical Copper (Bulldog Brand); copper 99.7, arsenic .3 (nominal); furnished as tubing; for hot forging, stamping, extruding, welding, drawing, turning, boring, etc.; resists heat to 406 degrees Fahr.; tensile strength 36,000-60,000 lbs. per sq. in.; high ductility; for condenser tubes and heat exchanger tubes.

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PHOS-COPPER—Westinghouse Electric & Mfg. Co., East Pittsburgh. Rod and strip material containing 7 per cent phosphorus and balance copper; highly corrosion resistant; gives strong joints when brazing assemblies of copper and copper alloys to each other.

1 2 - - - - - - - - -

PIONEER METAL—Pioneer Alloy Products Co. Inc., Cleveland. Approximately 65 nickel, chrome and molybdenum; castings; readily machinable; resists corrosion caused by sulfuric, nitric and phosphoric acid; resists heat to 2000 degrees Fahr.; tensile strength, ult., 74,000 lbs. per sq. in.; weldability, good; for valve and pump parts.

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PITTSBURGH STAINLESS STEELS — Pittsburgh Steel Co., Pittsburgh.

Stainless steels of various chromium-nickel-carbon types; 301, a high tensile material; 302, for food and meat packing equipment; 303, chrome-nickel-selenium type for screw stock; 304, similar to Type 302, advantageous for welded parts; 308, for cold heading requirements; 309, for welding rods where creep strength at elevated temperatures is a factor; 321, an 18-8 material with titanium added, for airplane parts; 347, similar to Type 321 but with better corrosion resistance; 310, chrome-nickel alloy for welding rod applications and where heat resistance is required; 316, chrome-nickel-molybdenum, acid resistant, for chemical and textile industries; 317, similar to Type 316 but more corrosion resistant; 410, heat treating type for use where high tensile and high rockwell hardness are desired; 414, similar to Type 410 but with somewhat different physical properties; 416, best machining qualities of these stainless steels but with only fair corrosion resisting properties; 430, corrosion resisting and fabricating properties not as good as Type 302, particularly good for trim; 446, high resisting steel with reasonably high creep strength.

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PLANEWELD—Lincoln Electric Co., Cleveland. Heavily-coated electrode of shielded arc type for welding of SAE 4130 and X4130 chrome-moly steel such as used in air-

1—*Corrosion resistant;* 2—*Heat resistant;* 3—*Abrasion resistant;* 4—*High tensile strength;* 5—*High ductility;*
6—*Bearing application;* 7—*Electrical uses;* 8—*Heat resistant;* 4—*High tensile strength;* 5—*High ductility;*

plane parts. Physical properties: Smooth welds with no under-cutting.

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PLATINUMCLAD—Baker & Co. Inc., Newark, N. J. Pure platinum welded to various base metals, furnished in sheet, tubing and wire. Resists corrosion caused by usual acids; medium abrasion resistance; good weldability; tensile strength, ductility, etc., are dependent upon properties of base metals. Used for tubing exposed to acids and for vessels subject to same.

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PLURAMELT—Allegheny-Ludlum Steel Corp., Pittsburgh. Combination of mild steel and stainless steel; furnished in sheets and plates; for stamping and welding; corrosion resistant; resists heat to 1500 degrees Fahr.; medium abrasion resistance; tensile strength approximately 65,000 lbs. per sq. in.; high ductility; good weldability; fair magnetic properties.

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POMPTON—Allegheny Ludlum Steel Corp., Pittsburgh. Carbon .95-1.05; for arbors, bushings, collets and lathe centers. Water hardening.

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PRECISION—Precision Castings Co. Inc., Syracuse, N. Y.

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Type A-12; aluminum base alloy; silicon 12, balance aluminum; resists heat to 1000 degrees Fahr., tensile strength, 33,000 lbs. per sq. in.; specific gravity, 2.66; for general aluminum die casting uses.

Type ZN-5; Zinc base alloy; aluminum 4, copper 1, magnesium .04, balance zinc; tensile strength, 42,000 lbs. per sq. in.; compressive strength, 85,000; specific gravity, 6.71; brinell hardness, 75; for general die casting uses—automotive, washing machines, electrical equipment, etc.

Type ZN-6; Zinc base alloy; aluminum 4, magnesium .04, balance zinc; tensile strength, 36,000 lbs. per sq. in.; compressive strength, 60,000; specific gravity, 6.60; brinell hardness, 65; for automotive and electrical equipment, washing machines, and miscellaneous mechanical parts.

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A-50; Aluminum base alloy; silicon 5, balance aluminum; furnished as castings; resists corrosion caused by atmosphere, foods, etc., resists heat to 1000 degrees Fahr.; abrasion resistance, medium; tensile strength, ult., 29,000 lbs. per sq. in.; ductility, medium; for use where corrosion resistance and ductility are essential.

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A-54; Aluminum base alloy; silicon 5, copper 4, balance aluminum; furnished as castings; resists corrosion caused by atmosphere; resists heat to 1000 degrees Fahr.; tensile strength, ult., 32,000 lbs. per sq. in.; general aluminum die cast parts.

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PROFERALL — Campbell, Wyant & Cannon Foundry Co., Muskegon Heights, Mich. Electric furnace high test cast iron, low carbon; chrome nickel molybdenum alloyed; furnished in two grades, 3-X and 5-X; for crankshafts and camshaft castings, high strength, heat resisting castings, hydraulic press and pressure castings, etc.

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PROMAL—Link-Belt Co., Indianapolis. Specially processed malleable iron; will withstand heavy loads without permanent distortion; where additional corrosion resisting properties are desired small percentages of copper can be added; can be hot-dip galvanized and will withstand repeated heating and cooling without growing brittle; uses include chain links, bearing caps, rocker arms, gears, sheaves, levers, and other machine parts subjected to severe service.

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PYTHON—Allegheny Ludlum Steel Corp., Pittsburgh. Carbon .85, vanadium .25; for chuck jaws, clutch pins and other parts requiring unusual wear and shock resistance. Water hardening.

Q

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Q-ALLOYS—General Alloys Co., Boston.

CN-1; chrome 22-26; nickel 10-12; resists corrosion due to attack from most all common acids and gases; brinell hardness 160-200 untreated; resists heat to 2100 degrees Fahr.; tensile strength, 75,000-95,000 lbs. per sq. in.; used for machine parts where corrosion resistance is desired.

CN-2; chrome 17-21, nickel 7-9; resists general corrosion; brinell hardness, 160-200 untreated, 160-200 heat treated; resists heat to 2100 degrees Fahr.; tensile strength, 70,000-80,000 lbs. per sq. in.; same use as above.

CN1-H; resists heat and corrosion; tensile strength, 80,000 lbs. per sq. in.; for castings subject to temperatures to 2100 degrees Fahr.

CN1-MO; same data as for CN-1, except that it contains 1-4 per cent molybdenum.

CN2-MO; same data as for CN-2, except that it contains 1-4 per cent molybdenum.

Chrome C1; chrome 25-30, nickel 3 max.; resists corrosion caused by mine water.

Chrome C2; resists corrosion caused by nitric acid; used for machine parts where corrosion resistance is desired.

Chrome C3; resists heat to 2000 degrees Fahr.; brinell hardness over 500 untreated; used for mill guides and any part requiring resistance to abrasion at high temperatures.

Grade A; resists heat to 2200 degrees Fahr.; nickel 65-68, chrome 15-19; tensile strength approximately 70,000-80,000 lbs. per sq. in.; annealing to remove casting stresses only; for machine parts requiring high temperatures to 2200 degrees Fahr.

Grade B; approximately 60 nickel, 12 chromium; resists heat to 2200 degrees Fahr.; tensile strength, approximately 65,000-75,000 lbs. per sq. in.; for use where temperatures to 2200 degrees Fahr. are required.

R

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RANDALL—Randall Graphite Products Corp., Chicago. S.A.E. No. 64 bronze or as specified; furnished as sand castings; resists corrosion caused by moisture; resists heat to 700 degrees Fahr.; high abrasion resistance; tensile strength, ult., 30,000 lbs. per sq. in.; medium ductility; good bearing properties; conductivity, good; brinell hardness, untreated 80; for use as bushings; graphite-inserted in the perforated or drilled hole, grooved, or reservoir types.
See advertisement, Page 69-D

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READYWELD—Lincoln Electric Co., Cleveland. Welding electrode for use with alternating current transformer type welders which have low open-circuit voltage. Possesses arc stability with easy re-striking. For general welding work on light gage sheet steel.

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RED ANCHOR—Anchor Drawn Steel Co., Latrobe, Pa. Carbon .95-1.1; commercial carbon drill rods; for precision shafts for motors, spindles, anvils and dental tools.

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REPUBLIC—Alloy Steel Div., Republic Steel Corp., Massillon, O. These alloy steels meet demands for material of lighter weight, greater strength, resistance to shock, impact and torsional strain, and high fatigue resistance; for severe service.

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REPUBLIC DOUBLE STRENGTH — Republic Steel Corp., Alloy Steel Div., Massillon, O. A low-alloy, copper-nickel-molybdenum steel with high tensile strength, excellent workability and resistance to atmospheric corrosion. Manganese .50-1, phosphorus .04 max., sulphur .04 max., copper .5-1.5, nickel .5-1.25, molybdenum .1 min., carbon in two ranges—Grade No. 1, .12 max., Grade No. 1-A, .3 max. Available in hot-rolled and cold-rolled sheets, hot rolled angles and formed sections; easily weldable, abrasion resistance. Used for lightweight construction.

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REX Z METAL—Chain Belt Co., Milwaukee. Furnished as castings; resists corrosion caused by weather and inorganic acids to a degree; resists heat to 1100 degrees Fahr.; high abrasion resistance; tensile strength, ult., 80,000 lbs. per sq. in.; medium ductility; specific gravity, 7.45; good bearing properties; brinell hardness, untreated 200; for cast parts requiring high strength and good machinability.

1 2 - - - 6 - - - -

REZISTAL—Crucible Steel Co. of America, New York.

Stainless irons; No. 12; 10-14 chromium. No. 17; 14-18 chromium. No. 20; 18-23 chromium. No. 27; 23-30 chromium. No. 162; 16 chromium, 2 nickel. No. 182; 18 chromium, 2 nickel. All foregoing have .12 max. carbon, except No. 20 and 27 which have carbon .33 max.

Stainless steels; a group similar to the foregoing except having a higher carbon content; used principally for bearings, cutlery, etc., where hardness and resistance to corrosion are desired.

Stainless A; .3 carbon, 12 chromium. B; .6 carbon, 16 chromium. B-100; 1 carbon, 17 chromium.

KA-2 (chromium 18, nickel 8 min., carbon .12 max.) and its modifications. No. 3; chromium 24, nickel 12. No. 4; chromium 20, nickel 25, silicon 2.5. No. 7; chromium 25, nickel 20. No. 2600; chromium 8, nickel 22.

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RITA—Cannon-Stein Steel Corp., Syracuse, N. Y.

No. 2; carbon .2, manganese 1.15, phosphorus and sulphur .05 max., nickel .5, chromium .3; brinell hardness, untreated 174, heat treated 388; carburizing 1650 degrees Fahr. and for toughening at 1550-1575 degrees Fahr.; resists corrosion due to chromium and nickel content; resists heat of 500-600 degrees Fahr.; tensile strength, 85,000 lbs. per sq. in. as rolled; for general machinery purposes where a free-cutting uniform material of great strength and toughness is desired.

No. 4; carbon .4, manganese .9, phosphorus and sulphur .08, chromium and nickel .5 max., brinell hardness, untreated 223, heat treated 461; recommended heat treatment, oil quenching, 1475 degrees Fahr.; resists corrosion due to chromium and nickel content, resists heat to 900 degrees Fahr.; tensile strength 105,000 lbs. per sq. in. as rolled. Recommended for spindles and shafts, toughness being reduced to render more readily machinable.

No. 5; carbon .5, manganese 1.2, phosphorus and sulphur .05 max., nickel .5 max., chromium .6; brinell hardness, untreated 269 heat treated 627, recommended heat treatment for oil quenching is 1500-1525 degrees Fahr.; resists corrosion due to chromium and nickel content; resists heat of 900-1000 degrees Fahr.; tensile strength, 130,000 lbs. per sq. in. as rolled; for gears, jaws, studs, bolts, axles, etc.

No. 7; carbon .65, manganese .5, phosphorus .045 max., sulphur .05 max., chromium .6, nickel 1.25; brinell hardness, untreated 179-223, heat treated 653; recommended heat treatment, water quenched, at 1425-1450 degrees Fahr.; oil quenched, at 1450-1475 degrees Fahr. Resists corrosion due to nickel and chromium content; resists heat of 700-800 degrees Fahr.; tensile strength, 135,000 lbs. per sq. in. as rolled; for expander and dowel pins, vise and wrench jaws, pneumatic hammer pistons, etc.

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RIVERSIDE—Riverside Metal Co., Riverside, N. J.

Beryllium copper; heat treatable copper alloy; has high tensile strength and ductility; for electrical parts, springs, diaphragms, jet tips, valve sleeves and seats, etc.

Phosphor bronze; copper tin alloy to which phosphorus has been added; has high strength and ductility; used in electrical appliances and machinery as springs, bearings, diaphragms, textile ring travelers, etc.

Nickel silver; copper, nickel, zinc in varying proportions; for diaphragms, radio and telephone springs, screw machine products, etc.

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ROL-MAN—Manganese Steel Forge Co., Philadelphia. Furnished in rods or bars, wire, sheets and plates, also hot forgings, stampings, wire cloth, welded and ground parts; contains manganese 11-14; carbon 1.1-1.4; resists heat to 400 degrees Fahr.; has high abrasion resistance; tensile strength, 140,000-160,000 lbs. per sq. in.; compressive strength 100,000; high ductility; nonmagnetic; brinell hardness, heat treated 190-210; used where abrasion resistance and high strength are needed; also for electrical uses.

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ROMAN BRONZE—Revere Copper & Brass Inc., New York. Copper 60, tin .75, zinc 39.25; for forging, flanging, upsetting; uses include piston rods, shafting, bearing applications, etc.

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RUSTLESS—Rustless Iron & Steel Corp., Baltimore.

1 2 3 - - - - - - -

13-HC-35, type 420; carbon .4 max., chromium 12-14; hardening type of stainless steel; brinell hardness 550; used for valve parts, knife blades, abrasion and corrosion resisting machine parts.

17-HC-60 and 90, type 440; carbon .6-1.1, chromium 14-18; hardening type of stain-

1—*Corrosion resistant;* **2**—*Heat resistant;* **3**—*Abrasion resistant;* **4**—*High tensile strength;* **5**—*High ductility;* **6**—*Bearing application;* **7**—*Electrical uses;* **8**—*Heat treating;* **9**—*Low specific gravity;* **10**—*Machinability*

less steel; brinell hardness 625; used for same type of machine parts as type 420.

1 2 - 4 - - - - - -

25-12, type 309: carbon .2 max., chromium 22-26; nickel 12-14; highly resistant to heat and creep to 1300 degrees Fahr., scaling to 2000 degrees Fahr.; resists nitric-sulphuric acid mixtures and sulphite liquors; used for furnace parts and for parts where corrosion conditions are severe.

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RUSTLESS 17—Rustless Iron & Steel Corp., Baltimore.

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Type 430; carbon .12 max. and chromium 14-18; resists sulphur gases, nitric, and organic acids; nonhardenable; for corrosion resisting rivets, screws, bolts and other parts.

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Type 430F; carbon .12 max., sulphur .15 min. and chromium 14-18; free-cutting stainless steel which resists heat to 1450 degrees Fahr.; tensile strength 100,000 lbs. per sq. in.

S

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SABECO—Saginaw Bearing Co., Saginaw, Mich.

No. 5 bearing bronze; copper 69-71, tin 4.5-5.5, lead 24-26, max., impurities .2; for light or medium load and water lubricated bearings.

No. 9; copper 69-71, tin 8.5-9.5, lead 20-22, max., impurities .2; for heavy loads such as average machine tool requirements.

No. 11; copper 69-71, tin 10.5-11.5, lead 18-20, max. impurities .2; for extra heavy unit pressures.

No. 11HG; copper 69-71, tin 10.5-11.5, lead 18-20, max. impurities .2; for worm wheels, clutch shifter shoes, forging machine slides, and extreme heavy bearing conditions.

No. 16; copper 69-71, tin 15-16.5, lead 13.5-14.5, max. impurities .2; for friction rings, and heavy duty boring spindle bearings.

See advertisement, Page 2-D

1 - 3 4 - - - - - -

SANDUSKY ALLOY IRON—Sandusky Foundry & Machine Co., Sandusky, O. Nickel, chrome and molybdenum cast iron alloys; furnished in tubing, centrifugally cast and in finished cylindrical parts; resists corrosion; high abrasion resistance; tensile strength 25,000-60,000 lbs. per sq. in.; brinell hardness, untreated, 160-300; heat treated, 300-600; used for rolls, liners, sleeves, bushings, cylinders, pipes and tubes.

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SANDUSKY BRONZES—Sandusky Foundry & Machine Co., Sandusky, O. Bronze, brass and manganese bronze alloys; furnished in tubing, centrifugally cast and in finished cylindrical products; resists corrosion due to composition and superior structure; tensile strength 30,000-110,000 lbs. per sq. in.; good bearing properties; brinell hardness, untreated, 40-250; used for rolls, liners, sleeves, bushings, cylinders, pipe, tubes of 3-46 inches in diameter and up to 330 inches in length.

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SCOVILL—Scovill Mfg. Co., Waterbury, Conn. A complete line of high and low brasses, phosphor bronzes, nickel silvers, and cupro nickels for various mechanical, electrical and heat-exchanger purposes.

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SCOVILL FREE-CUTTING BRASS ROD—Scovill Mfg. Co., Waterbury, Conn. Copper 61, lead 3, zinc 36; furnished in finished rods or bars, for hot forging, turning, boring, etc. Resists heat to 500 degrees Fahr.; abrasion resistance, medium; tensile strength, ult., 55,000-75,000 lbs. per sq. in.; ductility, medium; specific gravity, 8.5; bearing properties, fair. Specially adapted to fabricating on high speed screw machines.

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SCOVILL HARDWARE BRONZE—Scovill Mfg. Co., Waterbury, Conn. Copper 89, lead 2, nickel 1, balance zinc; furnished in rods, bars and wire for turning, boring, etc.; machinability good; resists corrosion caused by atmospheric conditions; tensile strength, 38,000-85,000 lbs. per sq. in.; specific gravity, 8.85; bearing properties good; recommended heat treatment, annealing, 1000-1100 deg. Fahr.; brinell hardness, untreated, 48-125; used for hardware and screw machine products.

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SCOVILL NAVAL BRASS—Scovill Mfg. Co., Waterbury, Conn. Copper 60, tin .75, zinc 39.25; furnished in finished rods or bars, and tubing, for hot forging, welding, turning, boring, etc. Resists heat to 500 degrees Fahr.; medium abrasion resistance; tensile strength, ult., 60,000-90,000 lbs. per sq. in.; ductility, medium; weldability, fair; specific gravity, 8.4. Used for boat shafting, turn buckles, welding rod, etc.

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SEMINOLE—Allegheny Ludlum Steel Corp., Pittsburgh. Carbon .45, chromium 1.3, tungsten 2, vanadium .25; for high creep strength bolts and studs for superheated steam; also machine parts having high wear and fatigue values. Withstands moderately elevated temperatures. Oil hardening.

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SHENANGO-PENN—Shenango-Penn Mold Co., Dover, O. Centrifugal castings in all bronzes, Monel metals and alloy irons; used for bearings, bushings, drums, liners, roll covers, sleeves, washers, rings, etc.

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SHIELD-ARC—Lincoln Electric Co., Cleveland.

Type 85; high tensile welding rod; recommended for fabrication of high tensile steels; brinell 190-250.

Type 100; brinell hardness 235-300.

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SHOCK PROOF — Lake City Malleable Co., Cleveland. Malleable iron of high tensile strength, high yield point and ability to withstand considerable shock loading and abuse, at the same time possessing good machining qualities; for cast parts to resist heavy strains, shocks and corrosion.

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SICROMO—Timken Steel & Tube Div., The Timken Roller Bearing Co., Canton, O.

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Type 1; carbon .15 max., manganese .5 max., phosphorus .03 max., sulphur .03 max., silicon 1-1.4, chromium .75-1.25, molybdenum .45-.65; furnished in rough bars or billets, finished rods or bars, and tubing, for hot forging, welding, turning, boring, etc. Material is corrosion resistant; heat resistant to 1050 degrees Fahr.; tensile strength, ult., 60,000 lbs. per sq. in., min.; fair weldability; and brinell hardness, annealed 163 max. For use in oil refinery field.

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Type 2; similar to above with slightly more chromium content.

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Type 2½; similar to Type 2 with slightly different silicon content.

Type 3; similar to Type 2½, with slightly higher silicon and chromium content.

1 2 - - - - - 8 - -

Type 5; similar to Type 3, with lower silicon content and more chromium.

Type 5S; similar to Type 5, differing only in higher silicon content.

1 2 - - - - - - - -

Type 7; similar to Type 5S, having lower silicon and higher chromium content.

1 2 - - - - - 8 - -

Type 9; similar to Type 7, having higher chromium content. All above materials are for oil refinery use.

Type 7M; similar to Type 7, but having an increased molybdenum content.

Type 9M; similar to Type 9, but having an increased molybdenum content.

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SIL-FOS—Handy & Harman, New York. Brazing alloy containing silver 15, copper 80, phosphorus 5; furnished in rods, wire, sheets and strips (coiled); corrosion resistant; high ductility; specific gravity 8.45; used to join nonferrous metals only, particularly copper, brass and bronze.

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SILFRAM—Stoody Co., Whittier, Calif. A hard-facing metal designed for application to parts subjected to corrosion, abrasion and impact.

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SILMO—Timken Steel & Tube Div., The Timken Roller Bearing Co., Canton, O. Carbon .15 max., manganese .5 max., phosphorus .04 max., sulphur .045 max., silicon 1.15-1.65, and molybdenum .45-.65; furnished in rough bars or billets, finished rods or bars, and tubing, for hot forging, welding, turning, boring, etc., into parts. Tensile strength, ult., 55,000 lbs. per sq. in. min.; resists heat to 1000 degrees Fahr.; fair weldability; brinell hardness, annealed 163 max. For use in oil refinery field.

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SILVER-PLY—Jessop Steel Co., Washington, Pa. Stainless-clad steel in any desired analysis; furnished as sheets or plates for stamping and welding into parts; corrosion resistant; high abrasion resistance; tensile strength, average, 63,000 lbs. per sq. in.; high ductility and good weldability; used for heads, tank wells, lids and any part in which corrosion resistance is important.

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SIMPLEX—Crucible Steel Co. of America, New York. Nickel 1.25, chromium .75; forging steel for machine parts requiring high strength and toughness; also available in case carburizing type.

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SIVYER—Sivyer Steel Castings Co., Milwaukee.

1 - - - - - 7 - - -

"Sixty"; chromium 18, nickel 8, carbon .12 max.; an austenitic nonhardenable corrosion resistant cast steel; also non-magnetic.

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"Sixty-four"; chromium 27, nickel 10, carbon .25 max.; characterized by high strength and better corrosion resistance than "Sixty."

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"Sixty-six"; chromium 11.5-13.5, carbon .12 max.; hardenable cast steel of medium corrosion resistance.

Five per cent chrome moly—a 5 per cent chromium, .5 molybdenum steel, for oil refinery and power plant service.

- 2 - - - - - - - -

"Seventy"; chromium 15, nickel 35.

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Hi-carbon chrome-moly; a 70 per cent chrome molybdenum air hardening cast steel for severe abrasion; for rolling mill rolls, wearing plates, etc.

6140; fine grained cast chrome vanadium steel for road machinery or excavator teeth, etc., combining abrasion resistance with good ductility.

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3140; chrome-nickel general purpose steel; composition properly balanced for liquid quenching.

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Manganese nickel; manganese 1.2, nickel .75 suitable for differential water quenching.

Manganese vanadium; manganese 1.25, vanadium .1; cast steel with combination of strength and ductility.

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Dynamo; a low carbon, low manganese steel with low residual magnetism.

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SOFTWELD—Lincoln Electric Co., Cleveland. For arc welding cast iron where easy machinability is required.

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STAINWELD—Lincoln Electric Co., Cleveland. Coated electrode for welding stainless steels or building up surfaces to resist corrosion.

Type A-5; for large number of so-called 18-8 stainless steels. Welds are of high tensile strength and ductility and possess same resistant qualities as the parent metal. Contains suitable amount of columbium to prevent intergranular corrosion of deposited metal.

Type A-7; for stainless steels of 18 per cent chromium, 8 per cent nickel type; fast-flowing, smooth operating; especially adapted for surfacing other steels with minimum admixture of base metal.

Type B; for arc welding stainless steel with chemical content of approximately 25 per cent chromium and 12 per cent nickel. Physical properties equal to metal welded.

Type C; a modification of the well-known 18-8 analysis, commonly known as 18-8 SMO (approx. 3½ molybdenum). Suitable for welding stainless steels of types 316-317 (Iron and Steel institute).

Type D; for stainless steels of 25 per cent chromium, 20 per cent nickel type; also for welding stainless steels to mild steel and for welding steels which are air-hardened and cannot be heat treated after welding.

1 2 3 - - - - - - -

STANDARD ALLOY—Standard Alloy Co., Cleveland.

Type H.R. 6; chromium 25, nickel 12; for castings; corrosion resistant; heat resistance 2000 degrees Fahr.; high abrasion resistance; tensile strength 80,000 lbs. per sq. in.; high ductility; good weldability.

Type H.R. 3; chromium 15, nickel 35; for

1—*Corrosion resistant;* **2**—*Heat resistant;* **3**—*Abrasion resistant;* **4**—*High tensile strength;* **5**—*High ductility;* **6**—*Bearing application;* **7**—*Electrical uses;* **8**—*Heat treating;* **9**—*Low specific gravity;* **10**—*Machinability*

castings; corrosion resistant; heat resistance 1850 degrees Fahr.; medium abrasion resistance; tensile strength 70,000 lbs. per sq. in.; good weldability.

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STANNUM BABBITT—Lumen Bearing Co., Buffalo. Tin base bearing babbitt.

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STERLING-NIROSTA Stainless Steels — Firth-Sterling Steel Co., McKeesport, Pa.

Types KA2, KA2-FC, KA2S and 19-9; of the 18-8 chrome-nickel group containing approximately 18 per cent chromium and 8 per cent nickel with various modifications or additions to give special physical properties, machinability or resistance to certain corrosive action; the free-cutting type can be easily machined, and cold work-hardened wire and strip have great strength and resiliency.

Type FC (303); free-machining 18-8 steel.

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STERLING Stainless Steels—Firth-Sterling Steel Co., McKeesport, Pa.

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Type A (420); carbon .35, chromium 13.5; corrosion resistant; tensile strength 240,000 lbs. per sq. in.; for ball bearings and automotive parts subject to wear. Good physical properties in heat-treated state; maximum resistance to corrosion secured by hardening and through grinding.

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Type T (410); carbon .1, chromium 13; possesses maximum strength and elasticity without sacrifice of toughness; machinable and corrosion resistant; for pump rods, shafts, valve parts, gun barrels, pistons and machinery parts, where strength is of greater importance than ease of machining.

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Type TX (403); modified Type T used for turbine blading.

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Type FC (416); free cutting stainless steel wherein a slight sacrifice in physical properties and corrosion resistance is made to obtain easier machining; for machine parts including screws, bolts, nuts, pump shafts, valves and spindles.

Type M (430); soft ductile steel that does not work-harden readily; requires no heat treatment to secure corrosion resistance.

Type MG (442); used where strength and toughness are secondary to workability and high temperature resistance.

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STOODITE—Stoody Co., Whittier, Calif. A hard-facing metal used chiefly as overlay on earth working equipment.

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STOODITE (Numbered)—Stoody Co., Whittier, Calif.; include Stoodite "45," "54" and "63," which range in physical properties from extreme hardness to extreme toughness. Rockwell "C" hardness indicated by numbers; designed for applications involving heat, impact or abrasion.

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STOODY (Self-Hardening)—Stoody Co., Whittier, Calif. A hard-facing metal used chiefly as an overlay on earth working equipment.

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STRAINFREE ELASTUF—Horace T. Potts Co., Philadelphia. Steel of manganese type without chromium, furnished in finished rods or bars; tensile strength 140,000 lbs. per sq. in.; medium ductility; nondistorting; high physicals; cold finished; brinell hardness, untreated 269. Used for parts whose length exceeds cross-sectional dimension as gears and worms with integral shafts.

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STRESSPROOF—La Salle Steel Co., Hammond, Ind. A modified SAE X1340 steel furnished in finished bars for machining; yield point 100,000 lbs. per sq. in.; and 90,000 lbs. per sq. in. depending upon the size; used for worm gears, lead screws, spindles, shafts and speed reducers.

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SUMET—Sumet Corp., Buffalo.

SM-4; lead 28 per cent; for light and medium duty bearings in high-speed service.

SM-8; lead 26; for moderately severe service.

SM-10; lead 24; for bearings subject to shock and impact.

SM-12; lead 22; for slow speed under heavy load and impact.

SM-14; lead 14; for severe service subjected to heavy shock.

SM-16; lead 20; for heavy duty slow-speed service.

SM-18; lead 17½; for severe service; uses include roll neck bearings; also suitable for gear blanks.

SM-22; lead 10; for extremely severe heavy-duty service; abnormal loads.

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SUMMERILL—Summerill Tubing Co., Bridgeport, Pa. Seamless tubing in practically all regularly used carbon grades from SAE 1010 to SAE 1.00. Others are chrome molybdenum SAE 4130X, 4140, 4150, 4185, 52,100, 4340; nickel silver, pure nickel silver, corrosion resistant steels—18-8, 16-13-3 and similar grades; 4 to 6 per cent chrome with ½ moly; also some of 12-14 per cent chrome. Used for mechanical specialties, aircraft, industrial control instruments, fuel injection tubing for diesel engines, etc.

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SUPERIOR STAINLESS—Superior Steel Corp., Carnegie, Pa.

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Type 410; chromium 10-14, carbon .15 maximum.

Type 430; chromium 14-18, carbon .12 maximum.

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Type 301; chromium 16-18, nickel 7-9, carbon .09-.2.

Type 302; chromium 18-20, nickel 8-10, carbon over .08-.2.

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SUPERLOY (Bulldog Brand)—Phelps Dodge Copper Products Corp., New York. Copper 88, tin 2, zinc 10; furnished in tubing for extruding and drawing; resists heat to 406 degrees Fahr.; specific gravity 8.78; for condenser tubes.

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SUPERMAL—The Jeffrey Mfg. Co., Columbus, O. High strength malleable iron; resists heat to 400 degrees Fahr.; high abrasion resistance; tensile strength 70,000 lbs. per sq. in.; medium ductility; brinell hardness, heat treated, 180-200; used for cast chains for drives and conveyor service.

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SUPERTEMP—Bethlehem Steel Co., Bethlehem, Pa. A patented alloy steel having high strength at high temperatures; suitable for bolts and studs for reaction chambers, cracking stills, superheaters, etc.

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SURFACEWELD—Lincoln Electric Co., Cleveland. A fine-grained alloyed powder for application with the carbon arc. Gives smooth abrasion resisting surface. Can be applied in thin layer. Properly applied, coating will have a hardness of 54 Rockwell C. Maintains hardness and resists scaling at high temperatures. Corrosion resistance comparable to stainless steel.

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T-1 ALUMINUM—The National Bronze & Aluminum Foundry Co., Cleveland. Copper 1.5-2.25, tin 1.25-1.75, magnesium .5-1, zinc .5-1.25, tin .1-.25, chromium .1-.3, iron 1 max., balance aluminum; furnished as finished castings or in rough bars or billets and ingots for sand casting; corrosion resistant; resists heat to 1100 degrees Fahr.; high abrasion resistance; tensile strength 30,000 lbs. per sq. in., min.; high ductility; good bearing properties; for use where light weight and high strength are needed.

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TALIDE—Metal Carbides Corp., Youngstown, O. Tungsten carbide metal; resists corrosion due to high tungsten content; heat resistant to 2000 degrees Fahr.; high abrasion resistance; tensile strength 300,000 lbs. per sq. in.; specific gravity 14.1; brinell hardness, untreated, 130 and over; for use as wear plates and guides, cutting tools, drawing dies and bushings.

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TAMCO—Titanium Alloy Mfg. Co., Niagara Falls, N. Y. Alloys including original high and medium carbon ferro carbon-titanium, foundry ferro titanium, and several varieties of low carbon ferro titanium for rolled, cast and forged steels, stainless and alloy steels, and gray cast iron. For the nonferrous field, alloys include TAM Webbite (alumino-titanium) for aluminum castings, cupro-titanium for copper, nickel-titanium, molybdenum-titanium, and special alloys for special purposes, in addition to metallic titanium and metallic zirconium.

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TEMP ALLOY—Continental Roll & Steel Foundry Co., East Chicago, Ind. Chrome alloy heat resisting cast iron used for furnaces and other designs subject to high temperatures and abrasion.

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TEMPALOY—American Brass Co., Waterbury, Conn. Copper, aluminum and nickel alloys which yield to heat treatment; abrasion resistant; uses include motor boat shafting, piston rods, bearing application, etc.

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TETON—Allegheny-Ludlum Steel Corp., Pittsburgh. Carbon 1, chromium 1.4; for balls and ball races, bushings, cams, etc. Usually hardened in oil.

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THERMOMETAL—The H. A. Wilson Co., Newark, N. J. Thermostatic bimetals furnished in strips and formed parts for temperature control and temperature compensation.

See advertisement, Page 69-D

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THOMASTRIP—Thomas Steel Co., Warren, O. Cold-rolled strip steel, bright finish uncoated and electro-coated in brass, bronze, nickel, zinc and tin.

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TI-COPPER NO. 39—Frontier Bronze Corp. A copper-chromium-titanium-silicon alloy furnished as castings; tensile strength, ult., 43,000-45,000 lbs. per sq. in.; compressive strength, ult., .001 at 23,000-25,000 lbs. per sq. in.; ductility, medium; nonmagnetic; brinell hardness, untreated 30-40, heat treated 100-120; for use in welding machines.

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TIGERLOY—Massillon Steel Casting Co., Massillon, O. Nickel-molybdenum; for shovel castings, gears, crane track wheels, castings for impact resistance, etc.

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TIMANG—Taylor-Wharton Iron & Steel Co., High Bridge, N. J. Nickel manganese steel; can be rolled, drawn, forged or shaped; for journal box liners, pedestal gib liners, conveyor flights, welding rod, etc.

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TIMKEN—Timken Steel & Tube Div., The Timken Roller Bearing Co., Canton, O.

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Type 17-22A; carbon .3-.35, manganese .5 max., chromium 1-1.5, molybdenum .45-.65, vanadium .25-.35, furnished in rough bars or billets, and finished rods or bars, for hot forging, turning, boring, etc. Heat resistant to 1200 degrees Fahr.; tensile strength, ult., 200,000 lbs. per sq. in., min., heat treated; medium ductility; and brinell hardness, untreated 200, heat treated 470 max. Used for bolts, studs and other highly stressed parts at elevated temperatures.

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Type 18-8; carbon .07 max., manganese .20-.70, silicon .75 max., chromium 17-20, nickel 8-10. This austenitic nonmagnetic alloy shows very good combination of creep and rupture strength, oil corrosion resistance, and oxidation resistance for service up to 1500 degrees Fahr.

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Type 16-13-3; carbon .13 max., manganese 1.5 max., chromium 15.5-17, nickel 12.5-14.5, molybdenum 2.5-3.25. This molybdenum modification possesses higher creep and rupture strength than the standard 18-8 analysis and is also more resistant to certain types of corrosion, especially those associated with pitting.

Type 4-6 Cr.Mo.; carbon .15 max., manganese .5 max., silicon .5 max., chromium 4-6, molybdenum .45-.65. For service up to 1200 degrees Fahr. where corrosion resistance to hot petroleum products is a primary requirement. Inferior in its oxidation and corrosion resistance to Sicromo 5S.

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Type .05 Mo. Steel; carbon .1-.2, manganese .3-.6, silicon .5 max., molybdenum .45-.65. For temperatures up to 1000 degrees Fahr. the satisfactory creep strength allows for greater safety than can be obtained from carbon steel. The oxidation and corrosion resistance, however, is similar to that of carbon steels.

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TIOGA—Allegheny Ludlum Steel Corp., Pittsburg. Carbon .67, manganese .6, chrome .65, nickel 1.4, molybdenum .2; combines good

1—*Corrosion resistant;* 2—*Heat resistant;* 3—*Abrasion resistant;* 4—*High tensile strength;* 5—*High ductility;* 6—*Bearing application;* 7—*Electrical uses;* 8—*Heat treating;* 9—*Low specific gravity;* 10—*Machinability*

degree of hardness and toughness with fair nondeforming quality; oil hardening; used for lathe centers, clutch parts, rivets, cams, arbors, spindles, gears, shafts, etc.

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TISCO—Taylor-Wharton Iron & Steel Co., High Bridge, N. J.

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Stainless steel castings of all compositions, including chrome-molybdenum, nickel-chrome-molybdenum, 18-8 chrome-nickel, and high chromium.

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Manganese steel castings for shock and abrasion resistance. Used primarily for rock crushers, ball mill liners, sprockets, etc.

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TOBIN BRONZE—American Brass Co., Waterbury, Conn. Copper 60, zinc 39.25, tin .75; abrasion resistant; uses include piston rods, boat shafting, condenser head plates, welding rods, seamless tubes, etc.

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TOLEDO ALLOY—Unitcast Corp., Steel Casting Div., Toledo, O.

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No. 3; carburizing steel, heat treated to give good machinability and uniform grain; excellent results obtained with short cycle carburizing treatment.

No. 4; abrasion resistant silicon-molybdenum steel with good hardening properties; used for mining tools, wear plates, crusher plates and pinions.

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No. 6; air hardening die steel of uniform machining qualities; long life under severe wear.

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No. 7; triple heat-treated manganese vanadium steel for many applications in the railroad and locomotive industry where extensive and repeated stress is encountered.

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No. 8; pearlitic manganese steel with analysis adjusted to give high tensile strength and ductility; used in automotive and aircraft equipment and other machines. Adaptable to flame hardening for selective treatment and oil hardening for complete quenching treatment.

No. 131; carbon .22-.28, manganese .7-.8, copper 1-1.2, vanadium .04-.08, silicon .4-.5; furnished in castings; tensile strength 90,-000-100,000 lbs. per sq. in.; high ductility; for use where high strength and ductility are required and when hardness is of lesser importance.

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TONCAN IRON — Republic Steel Corp., Cleveland. An open-hearth iron alloyed with .4 min. copper and .07 min. molybdenum; resists corrosion caused by atmosphere, water, oils and process materials; tensile strength, 45,000-58,000 lbs. per sq. in. min.; compressive strength 40,000; brinell hardness 90-120; for housing, piping, tubing, etc. Also enameling stock, available in sheet form.

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TOOLWELD — Lincoln Electric Co., Cleveland. Coated arc welding electrode providing a deposit with hardness of 683-71 brinell; hardness retained to 1000 degrees Fahr.; deposit can be heat treated same as high-speed steel; for building hard, tough cutting edges on cold rolled steel and for other applications requiring super-hardness.

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TOPHET—Wilbur B. Driver Co., Newark, N. J.

Type A; approximately 80 per cent nickel and 20 chromium; resists heat to 2100 degrees Fahr.; supplied in wire and strip form for electrical heating applications.

Type C; nickel, chromium and iron; resists heat to 1900 degrees Fahr.; supplied in wire and strip form; for electrical resistance and heating applications; heat resistant.

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TRANSWELD—Lincoln Electric Co., Cleveland. Heavily-coated electrode of shielded arc type for welding of steel in all positions with A.C. current; tensile strength 80,000-85,000 lbs. per sq. in.

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TRANTINYL—Youngstown Alloy Casting Corp., Youngstown, O. Furnished as sand castings. High abrasion resistance; medium ductility; high tensile strength; used for tools for tube and bar mills such as guide shoes, plugs, guides, etc.

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TRODALOY No. 1—General Electric Co., Schenectady, N. Y. Resistance welding electrode alloy containing 2.6 per cent cobalt, .4 beryllium, 97 copper; has 55 per cent conductivity of copper; 45,000 lbs. per sq. in. proportional limit; 220 brinell hardness; used for switch blades, cams, spring fingers, etc. All sales made through following licensees: P. R. Mallory Co., Ampco Metal Co., Electroloy Co., and Welding Sales & Engineering Co.

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TRUALOY—True Alloys Inc., Detroit.

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Copper; has high conductivity; castings for welding machines and conduction of current.

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Bearing bronze; low friction and wear, with high compressive strength; resistant to pounding and easy to machine.

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Aluminum; castings possessing high tensile strength, hardness and lightness.

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Aluminum bronze; for sand castings having corrosion resistance and tensile strength of 65,000 lbs. per sq. in.; recommended for parts subject to strain and wear.

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TRUFLEX Thermostatic Metals—General Plate Co., Attleboro, Mass. Furnished in sheets, strips and finished parts; can be stamped, welded and coiled; recommended heat treatments are 300-1000 degrees Fahr., depending on type and use. Available in various grades to meet specific thermostatic requirements.

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TUF-STUF — Mueller Brass Co., Port Huron, Mich. Available in several grades varying in copper, aluminum and iron content. Range of composition copper 80-90, aluminum 9-14, iron .5-4, nickel 0-5; high strength abrasion resistance, heat resistance, high brinell hardness and lightweight make it especially applicable to aviation industry for valve intake seats, bushings, gears, etc. Some compositions heat-treatable to brinell 275. Tensile of 90,000 lbs. per sq. in. obtainable on rods; special alloys have tensile of 125,000 lbs. per sq. in. Supplied as rods and forgings. Used also in pickling equipment in steel mills because of its resistance to sulphuric and hydrochloric acids.

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U-LOY—Republic Steel Corp., Cleveland. Copper-bearing steel with good corrosion resistance; available in hot rolled and galvanized sheets.

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UMA—Union Drawn Steel Div., Republic Steel Corp., Massillon, O. Free-machining steels; through the application of the Uma treatment abrasive inclusions which destroy tool life are eliminated. Available in following types: Freecut (SAE 1112), Supercut (SAE X-1112), Bessemer steels and SAE 1115, X-1315, X-1335, X-1015, 1015, 1035 and 1045 open hearth steels.

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UNION — Union Drawn Steel Div., Republic Steel Corp., Massillon, O.

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Freecut; carbon .13 max., manganese .6-.9, phosphorus .08-.11, sulphur .1-.2; a free-cutting bessemer type steel.

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Supercut; bessemer type; carbon .1 max., manganese .6-.9, phosphorus .08-.11, and sulphur .2-.3; similar to Freecut.

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Maxcut; free machining steel with tensile strength approximately same as S.A.E. X-1112; furnished in cold drawn bars.

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Multicut; similar to Maxcut with tensile strength approximately same as S.A.E. 1015.

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Hymo; carbon .15-.2, manganese 1-1.3, phosphorus .04 max., and sulphur .1-.18; recommended for spark plug shells, brake hose couplings, piston pins, king pins and carburized gears.

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Special Carburizing; carbon .13-.18, manganese .6-.9, phosphorus .04 max., sulphur .05 max., silicon .15-.30; recommended for piston pins and carburized gears.

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U. S. S.—United States Steel Corp., subsidiaries, including Carnegie-Illinois Steel Corp., Columbia Steel Co., National Tube Co., Tennessee Coal, Iron & Railroad Co., and American Steel & Wire Co.

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Type 302, U. S. S. 18-8; carbon .08-.2, chromium 18-20, nickel 8-10; resists heat to 1650 degrees Fahr., high abrasion resistance; atmospheric and acid resistant; tensile strength ult., 80,000-95,000 lbs. per sq. in. annealed, 185,000 lbs. per sq. in. cold worked; high ductility; weldability, good; brinell hardness, untreated, 135-185; for food processing and chemical equipment, etc., fabricated by other than welding.

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Type 303, U. S. S. 18-8 F. M.; carbon .2, manganese 1.50, phosphorus .15, molybdenum .6, silicon .75, chromium 17.5-20, nickel 8-10; resists corrosion caused by industrial corrosives; resists heat to 1600 degrees Fahr.; high abrasion resistance; tensile strength, ult., 80,000-95,000 lbs. per sq. in.; high ductility; brinell hardness, untreated, 135-220; for nuts, bolts, valve parts, and shafting.

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Type 304, U. S. S. 18-8-S; carbon .08 max., chromium 18-20, and nickel 8-10; similar to Type 302; abrasion resistant; high ductility; used where corrosion resistance is desired after fabrication by welding.

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Type 309, U. S. S. 25-12; carbon .2, manganese 2, phosphorus .03, silicon .75, chromium 22-26, nickel 12-14. Corrosion and heat resistant; high abrasion resistance; tensile strength, ult., 90,000-110,000 lbs. per sq. in.; high ductility; brinell hardness, untreated, 150-185; for high temperature service, 2100 degrees Fahr.

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Type 316, U. S. S. 18-8 Mo.; carbon .1, manganese 2, phosphorus .03, silicon .75, chromium 16-18, nickel 10-14 max., molybdenum 2 to 3. Corrosion and heat resistant; high abrasion resistance, tensile strength, ult., 80,000-95,000 lbs. per sq. in.; high ductility for chemical and food equipment.

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Type 321, U. S. S. 18-8-Ti.; carbon .1 max., chromium 17-20, nickel 7-10, silicon .75, manganese 2, phosphorus .03, titanium four times actual carbon minimum; high ductility; abrasion resistant; high temperature service and where welded parts are subject to corrosion.

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Type 347, U. S. S. 18-8 Cb.; carbon .1, chromium 17-20, nickel 8-12, manganese 2, phosphorus .03, silicon .75, columbium 10 times carbon min.; addition of columbium prevents susceptibility to intergranular corrosion; tensile strength, ult., 80,000-95,000 lbs. per sq. in.; high abrasion resistance; for high temperature service and where welded parts are subject to corrosion.

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Type 410, U. S. S. 12; carbon .15, manganese .75, phosphorus .03, sulphur .03, silicon .75, chromium 10-14, nickel .5, corrosion and oxidation resistant; responds to heat treatment and can be modified by addition of columbium, aluminum and molybdenum for specific application; tensile strength, ult., 65,000-85,000 lbs. per sq. in. annealed, 100,-000-200,000 lbs. per sq. in. heat treated; high ductility; high abrasion resistance; for turbine blading, shafting, valve parts, wire cable, screens, nuts and bolts.

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Type 416, U.S.S.-12 F.M.; carbon .15, manganese 1.25, phosphorus .04, sulphur or selenium .07 or molybdenum .6, silicon .75, chromium 12-14, nickel .5; similar to Type 410 except addition of sulphur, selenium or molybdenum increases the machinability; not to be used where welding is required; used for shafting, nuts, bolts, valve, trim and valve parts.

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Type 430, U.S.S.-17; carbon .12 max., manganese .75, phosphorus .03, sulphur .03, silicon .75, chromium 14-18, nickel .5; resists corrosion caused by nitric acid, atmosphere

1—*Corrosion resistant;* **2**—*Heat resistant;* **3**—*Abrasion resistant;* **4**—*High tensile strength;* **5**—*High ductility;*
6—*Bearing application;* **7**—*Electrical uses;* **8**—*Heat treating;* **9**—*Low specific gravity;* **10**—*Machinability*

and industrial corrosives; resists heat to 1550 degrees Fahr.; medium abrasion resistance; tensile strength, ult., 70,000-90,000 lbs. per sq. in., high ductility; used in nitric acid equipment, as screens, valves, shafting, nuts, bolts, rivets and plate construction.

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Type 446, U.S.S.-27; carbon .35, manganese 1, phosphorus .035, sulphur .035, silicon 1.5, chromium 23-30, nickel 1; resists heat to 2100 degrees Fahr.; medium abrasion resistance; tensile strength, ult., 75,000-95,000 lbs. per sq. in.; medium ductility; for high temperature service, where resistance to sulphides and concentrated nitric acid is required.

Type 501, U.S.S.-5; carbon over .1 and chromium 4-6.

Type 502, U.S.S.-5-S; carbon .1 max., chromium 4-6; molybdenum .5 is added to increase creep strength and avoid temper brittleness; columbium is added to eliminate air hardening and increase oxidation resistance slightly.

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Shelby 5 per cent chrome molybdenum tubing; used for furnace tubes in oil cracking stills, condensers and superheaters where high temperatures and pressures, and corrosive fluids are handled; chromium .15 max., manganese .5 max., silicon .5 max., carbon 4-6, and molybdenum .45-.65.

Shelby tubing may be obtained in many additional grades from the lowest carbon boiler tube steel to the stainless grades of alloy steel which are available in tubing in all sizes up to 10¾ inches outside diameter. A number of steels made to S.A.E. standards are also furnished in Shelby tubing.

Castings furnished by Lorain Div.; Type A-1; carbon .3-.4, chromium .75-1, nickel 2.5-3, manganese .6-.8, and molybdenum .3-.4; Type A3; carbon .45-.55, chromium .75-.9, nickel .6-.8, manganese 1.5-2, and molybdenum .3-.4; and Type MS-1; carbon 1-14, chromium .75-1, manganese 10-14.

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Electrical steel sheets for use in transformers, motors and generators; eleven principal grades of electrical sheets furnished—U.S.S. Pole, Field, Armature, Electrical, Motor, Dynamo, Radio Transformer 72, and Transformer 72, 65, 58, and 52.

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Other materials are furnished as follows: Carnegie-Illinois Steel Corp., stainless steel in sheets, plates, shapes and bars; National Tube Co., in pipe and tubular shape; and American Steel & Wire Co., in strip and wire forms.

See advertisement, Page 17-D

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U. S. S. AR STEEL (Abrasion Resisting Steel)—Carnegie-Illinois Steel Corp., Pittsburgh. Carbon .35-.5, manganese 1.5-2, phosphorus .05 max., sulphur .055 max., silicon .15-.3, copper .2 min. if specified; furnished in rough bars or billets, finished rods or bars, sheets, strips, plates, and shapes, for welding. Corrosion resistant if copper included; high abrasion resistance; tensile strength, ult., 100,000-125,000 lbs. per sq. in.; medium ductility; specific gravity, 7.8-7.9; brinell hardness 200-275 as rolled, heat treated 350-450; bearing properties, good. Used for wearing surfaces.

See advertisement, Page 17-D

U.S.S. CARILLOY—Carnegie-Illinois Steel Corp., Pittsburgh. Alloy steels in all standard grades of S.A.E. steels sold under the above tradename.

See advertisement, Page 17-D

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U. S. S. COR-TEN—Carnegie-Illinois Steel Corp., Pittsburgh. Carbon .12 max., manganese .5 max., phosphorus .07-.15, sulphur .05 max., silicon .25-.75, copper .3-.5, chromium .5-1; furnished in rough bars or billets, finished rods or bars, tubing, wire, sheets, strips, plates, structural and bar shapes, for hot forging, stamping, welding, riveting, turning, boring, etc. Resists corrosion caused by atmosphere, sea water; resists heat to 1525 degrees Fahr.; abrasion resistance, high; tensile strength, ult., 70,000 lbs. per sq in.; ductility, high; specific gravity, 7.8-7.9; bearing properties, good; weldability, good; brinell hardness, untreated, 165-190. Used for lightweight construction.

See advertisement, Page 17-D

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U.S.S. MAN-TEN—Carnegie-Illinois Steel Corp., Pittsburgh. Carbon .3 max., manganese 1.25-1.7, phosphorus .04 max., silicon .3 max., sulphur .05 max., copper .2 min.; furnished in rough bars or billets, finished rods or bars, tubing, sheets, strips, plates, structural and bar shapes, for hot forging, welding and riveting; corrosion resistant; high abrasion resistance; tensile strength, ult., 75,000 lbs. per sq. in.; high ductility; specific gravity, 7.8-7.9; good bearing properties and weldability; brinell hardness, untreated 175, heat treated 340; used for frames and light machine parts.

See advertisement, Page 17-D

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UNIVAN—Union Steel Casting Co., Pittsburgh. Nickel vanadium alloy; tensile strength 90,000 lbs. per sq. in.; for locomotive frames, crossheads, coupling boxes, driving wheel centers, etc.

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WAUKESHA — Waukesha Foundry Co., Waukesha, Wis. Copper base alloy with high nickel content; resists acids in food products; recommended for sand cast parts for food handling and dairy machinery. White in color, is easy to machine and also polishes well.

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WEARTUF—Horace T. Potts Co., Philadelphia. Carbon-manganese-silicon abrasion resisting alloy steel, furnished in sheets and plates, for hot forging, welding, forming, turning, boring, etc. Abrasion resistance, medium; ductility, low; good weldability; brinell hardness, untreated 265. Used for wear and abrasion resistant applications such as hoppers, chutes, conveyors and other similar types of parts.

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WEARWELD—Lincoln Electric Co., Cleveland; brinell hardness 488-548; suitable for hardfacing wearing surfaces subject to shocks and abrasion.

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WELLCAST 17 S — The Wellman Bronze & Aluminum Co., Cleveland. High-strength, aluminum-silicon-titanium alloy with high ductility; used in aircraft castings; tensile strength, 28,000-30,000 lbs. per sq. in.

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WILLIAMS No. 50 ALUMINUM BRONZE—E. A. Williams & Son, Jersey City, N. J. Furnished as sand castings; resists corrosion caused by almost all acids except nitric, hydrofluoric, sulphurous; abrasion resistance, high; tensile strength, ult., 25,000-85,000 lbs. per sq. in.; yield point 33,000-41,000 lbs. per sq. in.; medium ductility; bearing properties, good; brinell hardness, 167-175; for use as bushings, gears, worm wheels, acid equipment dies.

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WILLIAMS No. 51 SILICON BRONZE—E. A. Williams & Son, Jersey City, N. J. Furnished as sand castings; resists corrosion caused by all commercial acids, and sea water; high abrasion resistance; tensile strength 45,000-58,000 lbs. per sq. in.; high ductility; specific gravity 8.44; good bearing and welding properties; brinell hardness, untreated 90-100. Used for parts where strength, corrosion resistance and soundness are required.

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WILRICH—Wilcox-Rich Div., Eaton Mfg. Co., Detroit.

Type 301; abrasion and corrosion resistant alloy; available as centrifugal castings, blanks or finished parts; heat resistant to 1000 degrees Fahr.; tensile strength 66,000 lbs. per sq. in.; low ductility; specific gravity 7.75; good bearing properties. Used for cylinder sleeves, bushings, collets, etc.

Type 625; corrosion and abrasion resistant alloy; available as centrifugal castings, blanks and finished parts; resists heat to 1800 degrees Fahr.; medium ductility; specific gravity 7.68; good bearing properties. Used for rolls, dies, sleeves, seals, bushings, collets, etc.

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WILSON CONTACT MATERIALS, Electrical—The H. A. Wilson Co., Newark, N. J. Silver, platinum, tungsten and alloy contacts; silver-steel laminated contacts for projection welding; silver composite contacts; silver and platinum inlay and overlay on base metals. Furnished in sheet and wire.

See advertisement, Page 69-D

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WOLVERINE—Wolverine Tube Co., Detroit.

Aluminum brass; copper 76, zinc 22, aluminum 2; furnished in tubing; corrosion resistant; medium abrasion resistant; tensile strength 52,000-100,000 lbs. per sq. in.; for bushings, condenser tubing.

Admiralty brass; copper 70, zinc 29, tin 1; furnished in tubing; medium abrasion resistance; tensile strength 48,000-90,000 lbs. per sq. in.; for condenser tubing.

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70-30 brass; copper 70, zinc 30; furnished in tubing; corrosion resistant; medium abrasion resistant; tensile strength 48,000-88,000 lbs. per sq. in.; used for condenser tubing.

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Red brass; copper 85, zinc 15; furnished in tubing; corrosion resistant; medium abrasion resistance; tensile strength 40,000-69,000 lbs. per sq. in.; high ductility; for condenser tubing.

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Common high brass; copper 66, lead .65 max., zinc balance; furnished in tubing; corrosion resistance; medium abrasion resistance; tensile strength 48,000-85,000 lbs. per sq. in.; for cupped, formed or drawn parts, etc.

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Copper, oxygen-free; copper and silver 99.9 min., phosphorus .015-.035 (optional as deoxidizer); furnished in tubing; corrosion resistant; tensile strength 31,000-60,000 lbs. per sq. in.; high ductility; for condensers, evaporators, heaters and condenser tubes, sugar mills, refrigeration, etc.

Copper, arsenical; copper and silver 99.2 min.; phosphorus .015-.035, arsenic .15-.50; balance is the same as oxygen-free copper.

Commercial bronze; copper 90, zinc 10; furnished in tubing; corrosion resistant; available in color; medium abrasive resistance; tensile strength 36,000-63,000 lbs. per sq. in.; high ductility; for ornamental purposes.

Low brass; copper 80, zinc 20; furnished in tubing; resists corrosion; medium abrasive resistance; high ductility; tensile strength 43,000-78,000 lbs. per sq. in.; for bellows, ornamental purposes and fabricated parts.

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Phosphorized arsenical Admiralty brass; copper 70, zinc 29, tin 1, phosphorus .015 max., arsenic .35 max.; furnished in tubing; corrosion resistant; balance same as Admiralty brass.

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High brass (2 & 1); free turning; copper 66, lead 1.75, zinc balance; furnished in tubing; corrosion resistant; medium abrasion resistance; tensile strength 48,000-85,000 lbs. per sq. in.; machinability; for screw machine parts and fabricated parts.

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Naval brass; copper 60, tin .75, zinc balance; furnished in tubing; corrosion and abrasion resistance; tensile strength 55,000-100,000 lbs. per sq. in.; used where corrosion resistance with high strength is required.

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Muntz metal; copper 60, zinc 40, furnished in tubing; corrosion and abrasion resistance; tensile strength 48,000-85,000 lbs. per sq. in.; for condenser tubes, etc.

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Aluminum 2S; aluminum 99; furnished in tubing; ductility good; tensile strength 13,000-24,000 lbs. per sq. in.; machinability poor; used for airplane parts, oil burners, etc., where light weight is important.

Aluminum 3S; aluminum 97, manganese 1.25; furnished in tubing; ductility good; tensile strength 16,000-29,000 lbs. per sq. in.; machinability good; used for airplane parts, oil burners, etc., where light weight is desired.

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WORTHITE—Worthington Pump & Machinery Corp., Harrison, N. J. Nickel 24, chromium 20, molybdenum 3, silicon 3.5, carbon .07 max., other elements 2, balance iron; furnished in finished rods or bars and as sand and centrifugal castings for turning, boring, welding, etc.; corrosion resistant; heat resistance 2000-2200 degrees Fahr.; high abrasion resistance; tensile strength 97,000 lbs. per sq. in. hot rolled, 72,000 lbs. per sq. in. sand cast; medium ductility. Used for pumping equipment, valves, pipe fittings and special apparatus for corrosion resistance.

1—*Corrosion resistant;* 2—*Heat resistant;* 3—*Abrasion resistant;* 4—*High tensile strength;* 5—*High ductility;*
6—*Bearing application;* 7—*Electrical uses;* 8—*Heat resistant;* 4—*High tensile strength;* 5—*High ductility;*

X, Y

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X-7—General Alloys Co., Boston. Chrome 23-28, nickel 10-13; tensile strength 80,000 lbs. per sq. in.; recommended for castings subject to temperatures to 2000 degrees Fahr.

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XALOY — Wilcox-Rich Div., Eaton Mfg. Co., Detroit. Carbon 3.25, boron 1, silicon .75, nickel 4; available as centrifugal castings, blanks or finished parts; resists heat up to 800 degrees Fahr.; high abrasion resistance; tensile strength 30,000 to 45,000 lbs. per sq. in.; compressive strength 225,000; ductility low, specific gravity 7.58; good bearing properties; high magnetic properties; brinell hardness, as cast, 700 to 750. Used for rolls, dies, sleeves, seals, bushings, collets, etc.

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X-ITE—General Alloys Co., Boston. Nickel 37-40, chromium 17-21; for furnace parts not subjected to alternate heating and cooling cycles; standard material for commercial heat treating furnace parts.

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YOLOY—Youngstown Sheet & Tube Co., Youngstown, O. Special service alloy steel of increased tensile strength and high ductility combined with corrosion resistance, machinability and weldability.

Z

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Z-METAL—Ferrous Metals Corp., New York. Carbon 2-2.5, silicon 1, manganese .75-1, sulphur .08, phosphor .15; furnished as sand castings; resists heat up to 1000 degrees Fahr.; high abrasion resistance; tensile strength 75,000-90,000 lbs. per sq. in.; compressive strength 125,000; medium ductility; good bearing properties; high yield point; for use as cams, cranks, gears, rocker arms. Licensees: Chain Belt Co., Gunite Foundries Corp., Acme Stamping & Mfg. Co., Eastern Malleable Iron Co., Erie Malleable Iron Co., Arcade Malleable Iron Co., and Chicago Railway Equipment Co.

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ZAMAK—New Jersey Zinc Co., New York. Zinc alloys for die cast parts.
No. 2; aluminum 4.1, copper 2.7, magnesium .03, remainder Horse Head Special zinc.
No. 3; aluminum 4.1, magnesium .04, remainder Horse Head Special zinc.
No. 5; aluminum 4.1, copper 1, magnesium .03, remainder Horse Head Special zinc.

See advertisement, Page 80-D

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ZILLOY—New Jersey Zinc Co., New York. Copper .85-1.25, magnesium .006-.016, balance zinc; furnished in sheets and strips for stamping; resists corrosion caused by moisture; resists heat to 250 degrees Fahr.; medium abrasion resistance; tensile strength, 20,000-45,000 lbs. per sq. in.; compressive strength, 40,000-80,000; medium ductility; used for nameplates, small cover plates and caps, escutcheons, and molding trim.

See advertisement, Page 80-D

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ZINCGRIP — American Rolling Mill Co., Middletown, O. Galvanized sheet iron or steel, in strips or coils, with unusual forming and drawing qualities; for use wherever severe forming makes ordinary galvanized sheet metal unsatisfactory.

1—*Corrosion resistant;* **2**—*Heat resistant;* **3**—*Abrasion resistant;* **4**—*High tensile strength;* **5**—*High ductility;* **6**—*Bearing application;* **7**—*Electrical uses;* **8**—*Heat treating;* **9**—*Low specific gravity;* **10**—*Machinability*

Plastics and Other Nonmetallics Listed by Tradenames

(For listing by producing companies, and complete street addresses, see Page 52-D)

A

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ACE—American Hard Rubber Co., New York. Hard rubber; thermosetting; furnished in sheets, rods or tubes; may be machined, molded or stamped into part; corrosion resistance; low moisture absorption; high polish; tensile strength 4000-10,000 lbs. per sq. in.; heat resistance 140-190 degrees Fahr.; dielectric strength 450-550 volts per mil.; nonflammable. Uses include handles, caster wheels and special molded parts.

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AERTITE—Johns-Manville, New York. Rubbery, asphaltic-asbestos base; furnished in soft plastic form; corrosion resistant, heat resistant; nonflammable. Used on mechanical equipment to prevent air infiltration.

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AIRVULC—Self-Vulcanizing Rubber Co. Inc., Chicago. Gum rubber base; furnished in liquid; abrasion and corrosion resistant; tensile strength, 2000 lbs. per sq. in.; shock resistant; high polish; flexible; heat resistance, 212 degrees Fahr.; low moisture absorption; available in colors. Used as a sound deadener and for insulation and waterproofing.

1 2 - - - - - - - - -

AMERIPOL—The Hydrocarbon Chemical & Rubber Co., Akron, O. First introduced by B. F. Goodrich Co. under foregoing tradename; new one to be assigned by company. Butadiene Copolymer type of synthetic rubber, thermosetting; furnished in sheet form for molding, extruding, calendering, etc. Excellent abrasion resistance; corrosion resistance equal to that of rubber; very flexible; tensile strength up to 4500 lbs. per sq. in.; heat resistance 200-300 degrees Fahr.; low moisture absorption; available in color; shatterproof; specific gravity 1-1.5; used for gaskets, tubing, bumpers, vibration, insulators, packings, hose, printing rollers, printing rubbers, etc.

- - - - - 6 7 - 9 -

AMEROID—American Plastics Corp., New York. Casein base, thermoplastic; furnished in sheet or rod form, for machining; nonflammable; high polish; available in colors; corrosion resistant; tensile strength, 7600 lbs. per sq. in.; heat resistance, 150 degrees Fahr.; translucent; dielectric strength 290 volts per mil. Used for small knobs, bushings, washers and similar parts.

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AMPHENOL—American Phenolic Corp., Chicago. Type 912-B Ribbon; polystyrene base; thermoplastic; furnished in ribbon or thin sheeting from .0005-.015 in. thickness; .001 in. thickness can be highly polished; noncorrosive; flexible; available in colors; nonflammable; translucent; high tensile strength. Used as thin wall for electrical insulation.

Type 912; polystyrene base; thermoplastic; furnished in sheets, rods and tubes for laminating, molding, machining or stamping into parts; high dielectric strength; low moisture absorption; available in colors; translucent; nonflammable; high polish; corrosion resistance. Uses include electrical sockets, plugs, insulators and acid resistant tubing.

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ASBESTOPRENE—Victor Mfg. & Gasket Co., Chicago. Mineral-base asbestos; furnished in sheet and laminated form for stamping into parts; abrasion, corrosion and heat resistant; flexible; high tensile strength; low moisture absorption; nonflammable; shatterproof; used for gaskets in automotive and aviation engines, etc.

B

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BAKELITE—Bakelite Corp., New York.

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Phenolic plastics, general purpose; thermosetting; furnished in powder and blanks for plastic molding; corrosion resistant; dielectric strength 300-500 volts per mil.; nonflammable; tensile strength 6000-11,000 lbs. per sq. in.; low thermal conductivity; available in colors; takes high polish; low moisture absorption. Used for housings, knobs, handles, electric insulating parts, etc.

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Phenolic plastics, mineral filled. Similar to above but has high heat resistance and high dielectric strength, and lower moisture absorption; and is nonflammable.

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Phenolic plastics, fabric filled. Similar to general purpose phenolic plastics but are much higher in impact resistance; abrasion resistance; dielectric strength 300-400 volts per mil. Used for gears, bushings, bearings and heavy duty parts.

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Urea plastics. Thermosetting; furnished in powder form for plastic molding; specific gravity 1.47-1.52; tensile strength 9500-12,000 lbs. per sq. in.; dielectric strength 330-375 volts per mil.; nonflammable; takes high polish; available in colors. Used for housings and other parts requiring translucent or opaque colors resistant to fading.

- - 3 - - - - 8 9 10

Acetate plastics. Thermoplastic; furnished in powder form for plastic molding; in transparent, translucent and opaque effects, in all colors; takes high polish; impact strength .4-1.8 ft. lbs.; tensile strength 3000-6500 lbs. per sq. in.; suitable for wide variety of mechanical parts requiring brilliant color and high shock resistance.

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Polystyrene plastics. Thermosetting; furnished in powder form for molding; transparent, translucent and opaque effects, in all colors; takes high polish; nonflammable; low moisture absorption; specific gravity 1.05-1.07; dielectric strength 500-525 volts per mil.; resistivity 10^9 megohm centimeters; power factor .0002-.0003 from 60 cycles to 50,000 cycles; offers exceptional resistance to acids and alkalis.

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Cast resinoids C-1 and C-25; furnished in sheets, tubes, rods and special forms for casting and machining; translucent; available in colors; nonflammable; takes high polish; other properties similar to mineral and cellulose-filled. Used for decorative fittings, transparent gages, instruments or parts requiring resistance to hydrofluoric acid and other chemicals.

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BEETLE—Beetleware Division, American Cyanamid Co., New York. Urea formaldehyde base, thermosetting; furnished in powder and liquid for laminating or molding; available in colors; resistant to shock; translucent; high polish; dielectric strength 380 volts per mil.; tensile strength 7000 lbs. per sq. in.; nonflammable. Used for housings, cabinets, knobs, dials, panels and insulators. Material is available with slightly different properties for specific applications.

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BOOTH FELT—Booth Felt Co. Inc., Brooklyn, N. Y. Wool base felt; furnished in sheets or strips for machining or stamping into parts; heat resistance 400 degrees Fahr.; tensile strength, 5-100 lbs. per sq. in.; available in colors and in a variety of types and grades; used for washers, gaskets, grease seals, and pads for insulating machinery or reducing vibration.

See advertisement, Page 73-D

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BRANDYWINE FIBRE — Brandywine Fibre Products Co., Wilmington, Del. Paper chemically treated to form a solid homogeneous mass; furnished in tubes; dielectric strength 250 volts per mil.; tensile strength 5000-8500 lbs. per sq. in.; heat resistance 150-200 degrees Fahr.; available in colors; impact resistant; specific gravity 1.20-1.45. Used for spacers, ferrules, washers, handles, bearings and noiseless bumpers.

C

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C BOARD—Keasbey & Mattison Co., Ambler, Pa. Asbestos fiber furnished in sheet form to be machined or worked with carpenters tools. Corrosion resistant; tensile strength 1000 lbs. per sq. in. modulus or rupture; heat resistance 900 degrees Fahr.; nonflammable; takes color; compressive strength 500 lbs. per sq. in.; used as a sheet thermal insulation of low conductivity such as insulation for ovens, etc.

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CATALIN—Catalin Corp., New York. Phenolic base, thermosetting; furnished in sheets, rods, or special castings; high dielectric strength; nonflammable; low moisture absorption; high tensile and compressive strengths; **available in colors**; insoluble in ordinary solvents. Used for clock and instrument cases, auto fittings, knobs for electrical appliances, etc.

1 2 - - - 6 - - - -

CELITE—Johns-Manville, New York. Diatomaceous silica material; furnished in powdered, granular and brick forms; resistant to chemical corrosion; heat resistant; nonflammable. Used for insulation of equipment operating at high temperatures.

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CELLULOID—Celluloid Corp., Newark, N. J. Cellulose nitrate base, thermoplastic; furnished in sheets, rods and tubes, for molding, swedging, veneering, machining or stamping into parts; available in colors; high polish; tensile strength 5000-10,000 lbs. per sq. in.; flexible; resistant to corrosion; dielectric strength 600-1200 volts per mil; transparent. Used for instrument dials, tool handles, key buttons, register wheels, etc.

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CEL-O-GLASS—E. I. du Pont de Nemours & Co., Wilmington, Del. Plastic-coated wire mesh which transmits ultra-violet rays; corrosion resistant; resistant to shock; translucent; flexible; light weight. Used for sign boards, display backgrounds or any place where an opalescent or translucent, flexible material is required.

See advertisement, Page 8-D

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CELORON — Continental-Diamond Fibre Co., Newark, Del. Resinous base, thermosetting; furnished in molded laminated form, for machining into parts; corrosion resistant;

1—Corrosion resistant; 2—High heat resistant; 3—Impact resistant; 4—High tensile strength; 5—High dielectric strength; 6—Nonflammable; 7—Takes high polish; 8—Translucent; 9—Available in colors; 10—Low moisture absorption resistant to shock; high tensile and dielectric strength; low moisture absorption; high heat resistance and abrasion resistance; takes high polish. Grade C (canvas base) used for heavy-duty gears. Type L (linen base) used for small gears of fine pitch and narrow face.

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CODITE—Continental-Diamond Fibre Co., Newark, Del. Vulcanized fibre, thermoplastic; furnished in tubes, for machining into parts; high tensile and dielectric strength; translucent; flexible; high polish. Used for washers and parts requiring a hard, tough, flexible material.

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CORPRENE—Armstrong Cork Co., Lancaster, Pa. Compounds of cork and various synthetic rubbers. Two dozen types, having a wide range of physical properties; furnished in sheet, cut gasket and molded forms. Impervious to liquids and gases; highly resistant to deterioration by oils, solvents and most other liquids, gases, corona and weather; high and low coefficients of friction, high and low degrees of compressibility, lateral flow, etc.; available to meet specific requirements. Used as gaskets, packings, washers, valve disks, feed rolls, polishing wheels, airplane walkways, diaphragms, friction and vibration pads, etc.

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CRYSTALITE—Rohm & Haas Co. Inc., Philadelphia. Acrylic base, thermoplastic; furnished in molding powder for compression and injection molding; corrosion resistant; resistant to shock; transparent; flexible; specific gravity 1.18; tensile strength 4000-6000 lbs. per sq. in.; available in colors and high polish. Used for unbreakable gage dial covers and moldings of all kinds.

D

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DIAMOND — Continental-Diamond Fibre Co., Newark, Del. Vulcanized fibre, bone-like material; furnished in sheets, rods and tubes, for machining, sawing or punching into parts; high tensile and dielectric strengths; low specific gravity; tough; pliable; impact resistant. Used for insulating members, gears, bobbin heads, etc.

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DILECTO — Continental-Diamond Fibre Co., Newark, Del. Phenolic base, thermosetting; furnished in laminated sheets, rods and tubes, for machining or stamping into parts; dielectric strength 270-500 volts per mil; low moisture absorption; tensile strength 10,000-25,000 lbs. per sq. in.; corrosion resistant; heat resistance 290 degrees Fahr., available in colors; resistant to shock; takes high polish; impact resistant; insoluble. Used for electrical, thermal and mechanical insulating parts.

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DUFELT—Felters Co. Inc., Boston. Laminated felt and Neoprene. Various thicknesses and lamination arrangements. Corrosion resistant; high dielectric strength. Used for washers and strips for oil and grease retention where conditions do not permit use of plain felt seal. Petroleum resistant.

See advertisement, Page 69-D

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DUREZ—Durez Plastics & Chemicals Inc., North Tonawanda, N. Y. Phenolic base, thermosetting; powder form, for molding into parts; resistant to corrosion; high polish; low moisture absorption; heat resistance 350-550 degrees Fahr.; tensile strength 4000-7000 lbs. per sq. in.; available in colors; shock and abrasion resistant. Used for housings, handles, bases, knobs, electrical parts, small gears, frames, hoods, etc.

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DURITE—Durite Plastics Inc., Frankford Sta., P. O., Philadelphia. Phenol-furfural and phenol-formaldehyde synthetic resins, heatsetting; available in crushed, pulverized or liquid form, for bonding hot or cold molding compound, plywood, veneer, cements, abrasive articles, etc.; or in powder form for hot press molding; possesses high heat and shock resistance; high tensile and dielectric strengths. Used for cabinets, housings, handles, keys, knobs, automotive ignition, etc.

E

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EBROK—The Richardson Co., Melrose Park, Ill. Acid-resisting bituminous plastic for specific requirements including such parts as battery containers.

See advertisement, Page 14-D

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EEL-SLIP—Johns-Manville, New York. Asbestos fiber, graphite and rubber compound; heat resistant; high tensile strength; nonflammable. Used for bearings, suction box covers, etc.

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ETHOCEL—The Dow Chemical Co., Midland, Mich. Plastic granules, thermoplastic; furnished in granular form for injection and extrusion molding; dielectric strength 1500 volts per mil on .010-in. thickness; tensile strength 7000-8500 lbs. per sq. in.; heat resistance 130-150 degrees Fahr.; low moisture absorption, good dimensional stability, available in color; specific gravity 1.10-1.25; translucent; opaque; compressive strength 10,000-12,000 lbs. per sq. in. Used for articles when dimensional stability is required, etc.

See advertisement, Page 15-D

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ETHOFOIL—The Dow Chemical Co., Midland, Mich. Ethyl cellulose base thermoplastic, transparent or opaque; furnished in sheet form, can be laminated, heat-formed or cemented; corrosion resistant; flexible; dielectric strength 3500 volts per mil on .001-inch thickness; tensile strength 10,000 lbs. per sq. in.; heat resistance 250 degrees Fahr.; low moisture absorption; available in colors; specific gravity 1.14. Used for insulating foil, etc.

See advertisement, Page 15-D

F

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FARLITE—Farley & Loetscher Mfg. Co., Dubuque, Iowa. Phenolic and urea base, thermosetting; furnished in laminated sheets; for machining and stamping into parts; resistant to corrosion; high polish; low moisture absorption; impact resistant; translucent; available in colors; tensile strength 6000-8000 lbs. per sq. in.; dielectric strength 200-400 volts per mil. Used for sawed or stamped flat parts for light machine members.

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FARLOEX—Farley & Loetscher Mfg. Co., Dubuque, Iowa. Fibrous synthetic core with laminated Bakelite surface, thermosetting; furnished in laminated sheets, for machining into parts; dielectric strength 200 volts per mil; resistant to corrosion; high polish; resistant to impact; low moisture absorption; tensile strength 5000-6000 lbs. per sq. in.; heat resistant 450 degrees Fahr. phenolic; 370, urea. Used for low voltage insulation with moderate strength.

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FEATHERWEIGHT—Keasbey & Mattison Co., Ambler, Pa. Magnesia blocks, pipe covering and cement. Combination of magnesia and asbestos in powder or molded form with exceptionally low thermal conductivity. Used as a thermal insulating material where temperature does not exceed 600 degrees Fahr.

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FELTERS CERTIFIED FELT — Felters Co. Inc., Boston. Nonwoven felts to all S.A.E. and other specifications. Available either in the piece or cut to customer's requirements. Used for pads, bumpers, antisqueak and rattle parts, filters, polishing roll covering, shaft and bearing seals, etc. Petroleum resistant.

See advertisement, Page 69-D

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FIBERGLAS—Owens-Corning Fiberglas Corp., Toledo, O. Glass; furnished in flexible, semirigid and rigid forms; nonflammable; light in weight; high insulating value; resistant to corrosion; low moisture absorption; downy white in color. Used for electrical equipment, industrial insulation purposes and as filters in air conditioning equipment.

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FORMICA—Formica Insulation Co., Cincinnati. Resinous base, thermosetting; furnished in laminated form, for machining or stamping into parts; corrosion resistant; tensile strength is slightly less than cast iron; high dielectric strength; absorbs no oil; changes in dimensions only slightly as the result of moisture absorption. Used for insulating washers and bushings, punched parts in switches, automotive starting systems and all types of heavy-duty gears.

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FRANKLIN — Franklin Fibre-Lamitex Corp., Wilmington, Del. Hard vulcanized fibre; furnished in laminated sheets, rods or tubes; for machining and stamping; dielectric strength 200-400 volts per mil of thickness; tensile strength 12,000-15,000 lbs. per sq. in.; specific gravity 1.3-1.46; compressive strength 38,000-42,000 lbs. per sq. in.; nonflammable. Used for electrical insulation.

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FYBEROID — Wilmington Fibre Specialty Co., Wilmington, Del. Paper base; furnished in sheet form, for machining or stamping into parts; dielectric strength 200-400 volts per mil; tensile strength 5000-8000 lbs. per sq. in.; flexible; abrasion and corrosion resistant. Used for insulation on motors, generators, automotive ignition starters, etc.

G

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GASKOFELT—Western Felt Works, Chicago. Compact combination of felt with an oil resistant rubber compound of great density and high tensile strength. Used for gasketing in connection with oil, steam, hot or cold water; temperatures up to 250 degrees Fahr.; pressures up to 225 lbs.

See advertisement, Page 75-D

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GUMMON—Garfield Mfg. Co., Garfield, N. J. Black, cold-molded; corrosion and heat resistant (450 degrees Fahr.); high dielectric strength; high polish; resistant to hot oil. Will not shrink, crack, warp or deteriorate with age. Takes high polish. Used for insulated parts such as wiring devices and other small units.

H

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HASKELITE—Haskelite Mfg. Corp., Chicago. Waterproof plywood; light weight; high strength; elastic; hard; bendable into desired forms and shapes. Used for airplanes, buses, street cars, railways, radio cabinets and speakers, passenger cars, etc.

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HAVEG—Haveg Corp., Newark, Del. Phenolic base, thermosetting; furnished in finished form, molded or machined into parts; corrosion resistant; heat resistance 265 degrees Fahr.; resistant to shock and abrasion; tensile strength 5600 lbs. per sq. in.; low moisture absorption; nonflammable. Used for parts where chemical resistance is an important factor.

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HAVEGIT—Haveg Corp., Newark, Del. Phenol formaldehyde base, thermosetting cement; corrosion resistant (acids); heat resistant; low moisture absorption; properties similar to Haveg. Used in setting up brick and tile linings in chemical equipment.

1 2 - - - - - - - 10

HEMIT — Garfield Mfg. Co., Garfield, N. J. Cold-molded, gray-white refractory material; corrosion resistant; heat resistance 1100-1500 degrees Fahr.; low moisture absorption when impregnated; high dielectric strength; nonflammable. Used for interior parts of heating devices, or where a molded part must withstand an arc.

1 - 3 4 - - - - - -

HERESITE—Heresite & Chemical Co., Manitowoc, Wis. Phenolic resin, thermosetting; furnished in rods or tubes, powder or in laminated form, for molding, casting, and machining; corrosion, heat and impact resistant; high tensile and dielectric strengths; nonflammable; available in colors; translucent; low moisture absorption. Used for rayon machine parts and electrical equipment.

- 2 - - - 6 - - - -

HY-TEMP—Keasbey & Mattison Co., Ambler, Pa. Diatomaceous earth and asbestos base; combination heat insulating blocks, cements and pipe covering; furnished in powder or molded form; good corrosion resistance; rigidity; high heat resistance;

1—*Corrosion resistant;* **2**—*High heat resistant;* **3**—*Impact resistant;* **4**—*High tensile strength;* **5**—*High dielectric strength;* **6**—*Nonflammable;* **7**—*Takes high polish;* **8**—*Translucent;* **9**—*Available in colors;* **10**—*Low moisture absorption* low moisture absorption; nonflammable; and low thermal conductivity. Used for thermal insulation up to 1900 degrees Fahr.

I

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INCELOID—American Products Mfg. Co., (Inceloid Co. Inc., subsidiary) New Orleans. Cellulose derivative, thermoplastic; furnished in sheet and laminated form for casting into parts; corrosion and heat resistant; can be highly polished; flexible; high dielectric strength; low moisture absorption, available in colors; shatterproof. Used for electrical insulation, laminating work, etc.

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INDUR—Reilly Tar & Chemical Corp., Indianapolis. Phenolic base, thermosetting; furnished in powder form, for molding into parts; tensile strength 8560 lbs. per sq. in.; high dielectric strength; nonflammable; low moisture absorption; corrosion resistant; available in colors; specific gravity 1.37±. Used for instruments and machine accessories including insulating panels, knobs and handles, gears, etc.

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INDUR VARNISH—Reilly Tar & Chemical Corp., Indianapolis. Phenolic base, thermosetting; furnished in liquid form, for molding into parts; high dielectric and tensile strengths; nonflammable. Used for laminated gears.

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INSULKOTE — Johns-Manville, New York. Weatherproof coating for use over insulation of ducts and other exposed equipment; corrosion resistant; heat resistant; low moisture absorption.

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INSUROK—The Richardson Co., Melrose Park, Ill.

Thermosetting type; furnished in laminated sheets, rods and tubes for machining into parts, or as finished molded parts; corrosion resistant; low moisture absorption; high tensile strength; resistant to shock; comparatively low specific gravity. Used for gears, bearings, electrical insulation. Available in different grades.

Thermoplastic type; furnished in powder form for molding into parts; corrosion resistant; takes high polish; dielectric strength 500-700 volts per mil; tensile strength 5000-9000 lbs. per sq. in.; heat resistance 160-225 degrees Fahr.; low moisture absorption; nonflammable; available in color; specific gravity 1.05-1.2.

Translucent type; urea or phenolic base, thermosetting; furnished in molded and laminated sheets for signs, displays, rear illumination and changeable background signs, coin operated machine cabinet parts, etc. Material is translucent, does not support combustion, and has low moisture absorption.

See advertisement, Page 14-D

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IRV-O-LITE—Irvington Varnish & Insulator Co., Irvington, N. J. Thermoplastic, furnished in rods or tubes; abrasion resistant; corrosion resistant to 30 per cent acids or alkalis; very flexible; dielectric strength 750 volts per mil; tensile strength 2850 lbs. per sq. in.; softens above 300 degrees Fahr.; slow burning; available in color; translucent, transparent and opaque. Used for electrical insulation.

K

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"K" FELT—American Felt Co., New York. Kapok fiber 45, cotton 30 and wool 25; furnished in rolls approximately 24 yards long and 72 inches wide, in thicknesses from ⅛-inch to 1 inch in ⅛-inch increments, in white; flameproof; mothproof; low moisture absorption. Used for insulating material and numerous other purposes. Also available in S.A.E. felt specifications.

See advertisement, Page 61-D

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KNIGHT-WARE—Maurice A. Knight, Akron, O. Acid-proof chemical stoneware obtainable in a wide variety of special shapes and sizes; inert to corrosion of all chemical solutions or gases except hydrofluoric acid and caustic soda; very hard; excellent dielectric strength; resistant to heat but not sudden heat changes. Used for valves, pipes, jars, tanks, filters, towers, etc.

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KOMPO-KORK—Korfund Co. Inc., Long Island City, N. Y. Plates of finely granulated compressed cork with an oxidized linseed oil binder and burlap backing; corrosion and shock resistant; low moisture absorption. Used where irregularly shaped plates are required for isolating light machinery to combat vibration.

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KORFUND—Korfund Co. Inc., Long Island City, N. Y. Resilient mat of pure natural cork, steel bound and oil treated; corrosion and shock resistant; unaffected by acids and temperature changes; low moisture absorption. Used as machine bases to reduce vibration. Another isolator developed by the company is identical in construction, but is bound with asphalt and felt.

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KORK-RUBBER—Korfund Co. Inc., Long Island City, N. Y.—Plates of finely granulated cork and rubber particles compressed together; corrosion and shock resistant; low moisture absorption. Used for vibration dampening of light machines.

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KOROSEAL—B. F. Goodrich Co., Akron, O. Synthetic elastic; furnished in various consistencies from jelly to bone-like hardness; corrosion and shock resistant; available in colors. Jelly is used for making molds for plastic casts, but other compounds sold only as finished products. Superior to rubber in flexing, oxidation and penetration of moisture or gases; does not swell in oil. Available in molded and extruded forms; also applied as coating to paper and fabric.

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LAMITEX—Franklin Fibre-Lamitex Corp., Wilmington, Del. Phenolic base, thermosetting; furnished in laminated sheets, rods or tubes, for machining and stamping into parts; corrosion resistant; high polish; dielectric strength 500 volts per mil; tensile strength 15,000 ibs. per sq. in.; heat resistance 300 degrees Fahr.; low moisture absorption; nonflammable; compressive strength 35,000 lbs. per sq. in. Used for electrical insulation.

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LORD—Lord Mfg. Co., Erie, Pa. Rubber-bonded-to-metal, for a variety of uses including shear-type mountings for vibration insulation. Typical applications include aircraft automotive, and marine engines; motors, pumps, compressors, machinery, radio equipment, instruments, etc., where vibration is encountered.

See advertisement, Page 10-D

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LUCITE—E. I. du Pont de Nemours & Co. Inc., Wilmington, Del. Polymethyl-methacrylate base, thermoplastic; furnished in powder or sheets, rods and tubes, for molding, casting and machining into parts; translucent; high dielectric strength; available in colors; resistant to shock; low moisture absorption; high polish; resistant to corrosion; tensile strength 8000-10,000 lbs. per sq. in.; heat resistance 170-220 degrees Fahr. Used for panels, knobs, models, safety guards, dials and gage glasses.

See advertisement, Page 8-D

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LUMARITH—Celluloid Corp., Newark, N. J. Cellulose acetate base, thermoplastic; furnished in sheets, powder or rods and tubes; powders for compression and injection molding. Available in colors; tensile strength 5000-15,000 lbs. per sq. in.; dielectric strength 500-2500 volts per mil; high polish; flexible; resistant to shock and corrosion. Used for instrument dials and housings, radio grills, panels, airplane windshields, handles, knobs, register wheels, key buttons, electrical insulated parts, steering wheels, instrument panel knobs, etc.

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LUMARITH PROTECTOID — Celluloid Corp., Newark, N. J. Cellulose acetate base, thermoplastic; furnished in sheet and rolls or reels in thicknesses of .0007-.0001, for laminating, swedging, drawing, or stamping into parts; abrasion and corrosion resistant; flexible; dielectric strength 2000-25,000 volts per mil; tensile strength 5000-11,000 lbs. per sq. in.; heat resistant to 275 degrees Fahr.; slow burning to nonflammable; transparent. Used for laminated slot insulation paper for motors, wire insulation, formed insulators, etc.

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LUZERNE HARD RUBBER—The Luzerne Rubber Co., Trenton, N. J. Hard rubber, thermoplastic; furnished in sheets, rods or tubes, for molding and machining into parts; high polish; corrosion resistant to acids and alkalies; dielectric strength 6 x 10^7 megohms constant at 28.8 degrees Cent.; tensile strength 3500-9000 lbs. per sq. in.; heat resistant to 120 degrees Fahr.; available in some colors; specific gravity 1.24; compressive strength 8000-12,000 lbs. per sq. in. Used for molded machine parts.

M

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MAKALOT—Makalot Corp., Boston. Synthetic resinous base; furnished in powder form and also as varnish and sheet, for molding into parts; high tensile and dielectric strength; low moisture absorption; heat, shock and abrasion resistant; nonflammable; flowing and covering characteristics eliminate sticking troubles.

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MARBLETTE — Marblette Corp., Long Island City, N. Y. Cast phenolic resin furnished in sheets, rods, tubes and special castings to be fabricated into finished form; colors; opaque and translucent; mottled or plain; also "Crystle" (water-clear transparent); nonflammable; insoluble; infusible; noncorrosive; odorless; high tensile and dielectric strengths; high polish; easily machined.

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MICABOND — Continental-Diamond Fibre Co., Newark, Del. Fibrous, flexible material; furnished in sheets and tubing, for machining and forming into parts; heat resistant; high dielectric and tensile strength; nonflammable; low moisture absorption. Used for V-rings, washers, segments and various special shapes.

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MICAROK—The Richardson Co., Melrose Park. Ill. Sheet mica, thermoplastic; furnished in laminated sheets or tubes for molding and stamping into parts; abrasion and corrosion resistant; flexible to some extent; dielectric strength 325-625 volts per mil of thickness; heat resistance 500 degrees centigrade (India Mica) and 800 degrees (Amber, tightly clamped); low moisture absorption; nonflammable; shatterproof; specific gravity 2.25-2.65 according to grade; translucent in thin sheets only. Used for all kinds of electrical work where heat resistance, corona resistance and arc resistance are factors.

See advertisement, Page 14-D

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MICARTA—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Phenolic base, thermosetting; furnished in laminated sheet, rods or tubes; for molding, machining or stamping into parts; dielectric strength 50-700 volts per mil depending upon grade; low moisture absorption; resistant to shock, corrosion; high polish; flexible; tensile strength 6000-16,000 lbs. per sq. in.; available in colors; translucent; heat resistance 230; nonflammable; specific gravity 1.32-1.8 depending upon grade. Used for bearings, gears, bushings, washers, thermal and electrical insulation and parts exposed to acids, alkalies and common solvents.

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MONSANTO—Monsanto Chemical Co., Plastics Div., Springfield, Mass.

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Cellulose nitrate; thermoplastic; furnished in sheets, rods and tubes, or in laminated form, for machining, molding, stamping, swedging or blowing (steam) into parts; corrosion resistant; translucent; available in colors; flexible; dielectric strength 750-900 volts per mil; tensile strength 6000-9000 lbs. per sq. in.; low moisture absorption. Used for sight glasses, safety glass, oilproof insulation, dial covers, knobs, handles and structural models for strain study.

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Cast phenolic; thermosetting; furnished in sheets, rods and tubes, or laminated form; for casting and machining into parts; translucent; dielectric strength 250-700 volts per mil; corrosion resistant; tensile strength 6000-11,000 lbs. per sq. in.; high polish; moisture absorption .05-.5 per cent; available in colors. Used for safety shields, clock and radio cases, electrically insulated knobs and handles and structural models for strain study, and decorative trim.

1—*Corrosion resistant;* 2—*High heat resistant;* 3—*Impact resistant;* 4—*High tensile strength;* 5—*High dielectric strength;* 6—*Nonflammable;* 7—*Takes high polish;* 8—*Translucent;* 9—*Available in colors;* 10—*Low moisture absorption*

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Cellulose acetate; thermoplastic; furnished in sheet, laminated and powder forms or rods and tubes, for molding, machining, stamping or swaging into parts; resistant to corrosion; transparent; available in colors; flexible; tough; high polish; dielectric strength 540-1800 volts per mil; tensile strength 6000-6800 lbs. per sq. in. Used for safety glass, and compressible shims, couplings, gaskets, electrically insulated knobs and handles, light diffusing panels, and molded shapes of all descriptions.

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Butvar and Formvar; polyvinyl acetal thermoplastic; furnished in resin, molding powder or sheet form; extremely tough from freezing temperatures to over 120 degrees Fahr.; sheet has great flexibility and rubberiness; dielectric strength 800 volts per mil. Used for safety glass, gaskets, adhesives, injection and compression molded shapes.

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Polystyrene; thermoplastic; styrene base; furnished in powder for molding into parts; abrasion resistance fair; can be highly polished; corrosion resistant; dielectric strength 500-700 volts per mil; tensile strength 5500-8500 lbs. per sq. in.; low moisture absorption; available in color; specific gravity 1.07; clear to opaque. Used for electrical insulating parts, etc.

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MONSANTO RESINOX—Monsanto Chemical Co., Plastics Division, Springfield, Mass. Phenolic molding compounds, in standard and special formulas, thermosetting; heat-resistant; specific gravity 1.44; flexural strength 9200 lbs. per sq. in.; tensile strength 6800 lbs. per sq. in.; impact strength 2.5 ft. lbs. per sq. in.; water absorption .63 per cent by weight. Used in electrical equipment, large housings, radio cabinets, etc. This tradename also refers to phenolic impregnating and treating resins.

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NATIONAL CARBON — National Carbon Co. Inc., Cleveland. Carbon or graphite in amorphous or graphite form; made in a variety of shapes; molded, extruded or machined into parts. In graphitic form carbon possesses excellent lubricating properties; highly resistant to most acids, alkalies and solvents. Used for sleeve bearings, packings, threaded parts, nozzles for corrosive liquids, etc.

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NATIONAL FIBRE—National Vulcanized Fibre Co., Wilmington, Del. Converted cotton cellulose, chemically pure, tough horn-like material; furnished in hard or flexible form in sheets, rolls, tubes, rods and fabricated shapes; high dielectric and mechanical strengths; resistant to abrasion and shock; easily formed and machined; light in weight. Used for gears, valve disks, gaskets, washers, bobbin heads, electrical insulation, etc.

See advertisement, Page 75-D

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NATIONAL SWITCH INSULATION—National Vulcanized Fibre Co., Wilmington, Del. Combination laminated Bakelite core with vulcanized fiber surfaces; available in sheets and fabricated shapes; high tracking (arc) resistance combined with rigidity and minimum warpage; high dielectric and mechanical strengths; low moisture absorption; easily stamped and fabricated. Used in switches to support and insulate current-carrying parts.

See advertisement, Page 75-D

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NEILLITE—Watertown Mfg. Co., Watertown, Conn. Phenolic base, thermosetting; molded into parts; high tensile and dielectric strengths; corrosion resistant. Used for mechanical and electrical purposes.

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NEOPRENE—E. I. du Pont de Nemours & Co. Inc., Wilmington, Del. Chloroprene rubber; available as hose, wire, cable, sheets, tank linings, gaskets, packing, tubing, belting, diaphragms, industrial truck tires and molded goods. Used as binder for cork and asbestos. Is employed to impregnate or coat canvas, duck or other fabrics. Strength, abrasion resistance, resilience and elasticity of rubber; resistance to deterioration from contact with oils, greases, gasoline, heat, chemicals, sunlight and ozone; corrosion resistant; will not support combustion; low moisture absorption; tensile strength 4000 lbs. per sq. in.; available in colors. Used for machine applications where rubber characteristics are required but where the product is to be subjected to deteriorating influences.

See advertisement, Page 8-D

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NIGRUM—Bound Brook Oil-less Bearings Co., Bound Brook, N. J. Impregnated hard wood bearings and washers; hard maple impregnated with 40-50 per cent lubricant by volume; used in loose pulleys, automotive, textile, foundry equipment, etc.

See advertisement, Page 59-D

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OHMOID—Wilmington Fibre Specialty Co., Wilmington, Del. Phenolic base, thermosetting; furnished in laminated sheets, rods and tubes, for machining or stamping into parts; dielectric strength 200-700 volts per mil; moisture absorption 2 per cent; insoluble in ordinary solvents; high polish; corrosion resistant; tensile strength 10,000-14,000 lbs. per sq. in.; heat resistance 250-300 degrees Fahr. Used for electric and mechanical insulation.

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PANELYTE—The Panelyte Corp., New York. Laminated phenolic paper or fabric base, with surface of urea-formaldehyde type in colored grades; supplied in sheet, strips, rod, tube and molded form; also fabricated to size; good mechanical strength; resistant to acids and alkalies; low moisture absorption; lightweight; specific gravity 1.38. Used for refrigerator door panels, breaker strips, radio and electrical insulation, gears, pinions and structural parts; also in decorative grades for table tops, panels, etc.

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PEERLESS—National Vulcanized Fibre Co., Wilmington, Del. Converted cotton cellulose, chemically pure, fish paper insulation; furnished in sheets and rolls; high dielectric strength combined with toughness, springiness and good bending properties. Used extensively for generator and motor insulation and various electrical applications.

See advertisement, Page 75-D

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PENN—Penn Fibre & Specialty Co., Philadelphia.

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Vulcanized fiber; cotton rag paper base; furnished in sheets, rods or tubes for machining and stamping into parts; tensile strength 12,000-15,000 lbs. per sq. in.; compressive strength 38,000-42,000 lbs. per sq. in.; shearing strength 9000-13,000 lbs. per sq. in.; heat resistant to 650 degrees Fahr.; dielectric strength 200-400 volts per mil; specific gravity 1.36-1.46; flexible; insoluble in ordinary solvents; available in color. Used for washers, shims, gears, bases, knobs, gaskets and insulating parts.

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Phenol fiber; a phenolic treated paper or canvas and linen; furnished in laminated sheet, rods or tubes for machining and stamping into parts; specific gravity of paper base 1.36, fabric base 1.38; water absorption of paper base .4-.8, fabric base .4-.6 at 24 hours immersion; resistance to heat, paper base 125 degrees Cent., fabric base 110 degrees Cent.; safe limit for constant pressure, paper base 257 degrees Fahr., fabric base 230 degrees Fahr.; tensile strength, ult. paper base 14,000 lbs. per sq. in., fabric base 10,000 lbs. per sq. in.; dielectric strength, volts per mil, paper base 450, fabric base 225 on ⅛-inch thickness, paper base 700 and fabric base 500 on 1/32-inch thickness; shatterproof. Used for washers, gears, shims, bearings, gaskets, disks, insulation, etc.

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PHENOLITE—National Vulcanized Fibre Co., Wilmington, Del. Laminated Bakelite; furnished with base of paper, cloth or asbestos in sheets, rods, tubes and fabricated shapes; also laminated with rubber sheet; high dielectric and mechanical strengths; low moisture absorption; heat resistant; infusible; resistant to acids, solvents and oils; high resistance to wear and impact; machinable. Used in electrical, mechanical and chemical applications for silent gears, bearings, bushings, washers, valve disks, terminal strips, etc.

See advertisement, Page 75-D

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PLASKON—Plaskon Co. Inc., Toledo, O. Urea formaldehyde base, thermosetting; furnished in powder form, for molding into parts; translucent; tensile strength 8000-13,000 lbs. per sq. in.; available in colors; corrosion resistant; high polish; dielectric strength 500-700 volts per mil (60 cycles); heat resistance 175 degrees Fahr.; resistant to shock; low moisture absorption. Used for housings, trim, knobs, dials, etc.

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PLASTACELE—E. I. du Pont de Nemours & Co. Inc., Wilmington, Del. Cellulose acetate base, thermoplastic; furnished in powder, sheets, rods and tubes, for machining and molding into parts; available in colors; transparent; resistant to shock; high polish; corrosion resistant; flexible; dielectric strength 700-1000 volts per mil; tensile strength 3000-8000 lbs. per sq. in.; heat resistance 185-250 degrees Fahr. Used for machine guards, models, control panels, dials, knobs, steering wheels, safety glass screens, etc.

See advertisement, Page 8-D

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PLEXIGLAS—Rohm & Haas Co. Inc., Philadelphia. Acrylic base, thermoplastic; furnished in sheets and rods; corrosion and shock resistant; transparent; flexible; specific gravity 1.18; tensile strength 7000-9000 lbs. per sq. in.; available in colors; high polish. Used for unbreakable inspection windows.

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PLYMETAL — Haskelite Mfg. Co., Chicago. Waterproof plywood, sheet metal bonded to one or both faces; has stiffness, rigidity; lightweight; metal on both faces insuring freedom from warpage. Types available for different purposes are galvannealed steel, stainless steel, aluminum, copper, chrome zinc, chrome steel, porcelain, etc. Used in automotive and aircraft fields.

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POLAROID — The Polaroid Corp., Cambridge, Mass. Light-polarizing glass and film. Principal property is 99.5 per cent polarization of transmitted light, uniformly over large area. Used for camera filters, polarizing attachments for microscopes, refractometers and other scientific instruments. Also for model structures to determine strain, three-dimensional motion picture apparatus, glareless auto headlights, etc.

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PRYSTAL—Catalin Corp., New York. Phenolic base, thermosetting; furnished in sheets, rods or special castings; nonflammable; transparent; low moisture absorption; high dielectric strength; corrosion resistant; available in color; insoluble; shatterproof; high refractory index. Used to replace glass.

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PVA—E. I. du Pont de Nemours & Co., Wilmington, Del. Thermoplastic, polyvinyl alcohol; furnished in powder form for molding and casting; highly flexible; low dielectric strength; heat resistance up to 212 degrees Fahr.; takes color; shatterproof; specific gravity 1.3 powder; translucent; resistant to organic solvents. Used for oil resistant gaskets, tubes, rollers, etc., as well as protective coatings on metal parts.

See advertisement, Page 8-D

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PYRALIN—E. I. du Pont de Nemours & Co. Inc., Wilmington, Del. Nitrocellulose base, thermoplastic; furnished in sheets, rods and tubes, for machining into parts; transparent; available in colors; shock and corrosion resistant; high polish; flexible; dielectric strength 300-750 volts per mil; tensile strength 5000-10,000 lbs. per sq. in. Used for handles, gage glasses, instrument covers, models, safety glass screens, etc.

See advertisement, Page 8-D

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PYREX—Corning Glass Works, Corning, N. Y. Trademark indicates manufacture by above. Glass products such as tubing, cylinders, sheets, molded parts, etc., covering a great range of desirable chemical, physical and optical properties such as heat resistance, low or high thermal conductivity, low or high coefficient of expansion, excellent corrosion resistance, no appreciable moisture absorption, nonflammable, ability to bond to metal. Over 250 glasses regularly melted.

1—Corrosion resistant; 2—High heat resistant; 3—Impact resistant; 4—High tensile strength; 5—High dielectric strength; 6—Nonflammable; 7—Takes high polish; 8—Translucent; 9—Available in colors; 10—Low moisture absorption specific properties of typical product, PYREX brand piping, as follows: Linear coefficient of expansion .0000018 inches per deg. Fahr. between 66 degrees Fahr.-660 degrees Fahr. Thermal conductivity 8.1 B.t.u./sq. ft. /hr./in./° Fahr. at 77 degrees Fahr. Tensile strength from 6000 to 10,000 lbs. per sq. in.; dielectric strength 2700 KV per inch.

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PYROFLEX — Maurice A. Knight, Akron, O. Depolymerized colloidal resin base, thermoplastic; furnished in lump or sheet form; applied by dipping or flame cementing sheets to parts; corrosion resistant; high dielectric strength; low moisture absorption. Good bonding material where temperatures are not too high.

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PYROPLAX—Cutler-Hammer Inc., Milwaukee. Asbestos base; furnished in cold-molded pieces; heat resistance 800-1000 degrees Fahr.; nonflammable; dielectric strength 40 volts per mil; resistant to corrosion and abrasion. Used for machine parts where resistance to high temperature and electric arc is required.

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RESILON—United States Stoneware Co., Akron, O. Resinous thermoplastic; furnished in sheets and lumps to be molded and cast into machine parts; corrosion resistant; flexible; high dielectric strength; tensile strength; heat resistant; shatterproof. Used for lining parts to resist corrosive attack.

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RESISTOFELT—Western Felt Works, Chicago. A lamination of high-grade wool felt and Neoprene. Used on revolving shafts; the felt lubricates the shaft and prevents entrance of dust; the Neoprene prevents passage of oil.

See advertisement, Page 75-D

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RESISTOFLEX PVA—Resistoflex Corp., Belleville, N. J. Polyvinyl alcohol base, furnished in laminated sheets, rods, tubes or hose, to be molded, cast, machined, stamped and extruded into parts; semifinished tubing and sheets furnished also for further molding; corrosion, abrasion and heat resistant; nonflammable; available in color; translucent; high tensile strength. Used for hose, gaskets and seals for fuel and lubricating units, hydraulic mechanisms and controls, oil filters, air conditioning units, refrigerant purging lines, chemical solvent hose, fire extinguisher hose, etc.

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REVOLITE — Atlas Powder Co., Zapan Div., Stamford, Conn. Cloth base impregnated with Bakelite resin; furnished in either laminated or single ply form; heat resistant; high dielectric strength; corrosion resistant; low moisture absorption; impact resistant. Used for cable wrappings, diaphragms for pumps and valves, gaskets and flexible connections for machinery such as pulverizers, and coated asbestos laundry roll covers for flat work ironers.

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RUB-EROK—Richardson Co., Melrose Park, Ill. Special rubber furnished in sheet form to be molded; can be highly polished; corrosion resistant; flexible; high dielectric strength; low moisture absorption. Used for electrical insulation.

See advertisement, Page 14-D

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RUB-TEX—The Richardson Co., Melrose Park, Ill. Hard rubber; molded into parts, particularly desirable for electrical, heat and cold insulation; adapted to many industrial uses.

See advertisement, Page 14-D

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RYERTEX—Joseph T. Ryerson & Son Inc., Chicago. A nonmetallic bearing material designed for use with water lubrication primarily; high shock resistance; suitable for bearing loads to 5000 lbs. per sq. in.; resistant to acids and mild alkalies.

See advertisement, Page 22-D

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SARAN—The Dow Chemical Co., Midland, Mich. Crystalline, thermoplastic, fibrous, aliphatic chloride, polymeric base; furnished in special extruded and molded fabricated forms; corrosion resistant; very tough and flexible; tensile strength 40,000-60,000 lbs. per sq. in. (extruded); no moisture absorption; abrasion resistant; high polish; high dielectric strength; shatterproof; nonflammable, available in color; transparent to opaque; used for moldings, gaskets, packing, tubing, belting, etc.

See advertisement, Page 15-D

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SELFVULC—Self-Vulcanizing Rubber Co. Inc., Chicago. Self, cold curing gum rubber; furnished in plastic or liquid form; resistant to corrosion and abrasion; tensile strength 2000 lbs. per sq. in.; resistant to shock; flexible; heat resistance 212 degrees Fahr.; low moisture absorption; available in colors. Used in machines as a sound deadener, insulation and waterproofing.

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SIRVENE—Chicago Rawhide Mfg. Co., Chicago. Synthetic rubber compounds molded into parts; resistant to oils and heat, oxidation and weather. Used for sealing oils and greases, packings, gaskets, covers and special parts.

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SIRVIS—Chicago Rawhide Mfg. Co., Chicago. Special tanned abrasive and heat resisting leather. Used for all types of packings, gaskets and mechanical leather parts.

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SPAULDING ARMITE — Spaulding Fibre Co. Inc., Tonawanda, N. Y. Fibrous material; furnished in sheets and laminated forms for machining, stamping or forming into parts; flexible; dielectric strength 200-550 volts per mil; compressive strength 40,000 lbs. per sq. in.; abrasion and corrosion resistant; tensile strength 9000-15,000 lbs. per sq. in.; available in colors; high polish.

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SPAULDING FIBRE—Spaulding Fibre Co., Inc., Tonawanda, N. Y. Fibrous material; furnished in sheet and laminated forms or rods and tubes, for machining, stamping or forming into parts; dielectric strength 150-400 volts per mil; tensile strength 9000-15,000 lbs. per sq. in.; flexible; abrasion and corrosion resistant; available in colors; resistant to shock. Used for mechanical applications where toughness, light weight and machining and forming properties are essential.

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SPAULDITE—Spaulding Fibre Co. Inc., Tonawanda, N. Y. Phenolic base, thermosetting; furnished in sheet and laminated rods and tubes for machining or stamping into parts; dielectric strength 700 volts per mil; low moisture absorption; high polish; corrosion and heat resistant (220 degrees Fahr.); resistant to shock. Used where resistance to moisture and chemicals, appearance and permanence are essential.

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SPAULDO—Spaulding Fibre Co. Inc., Tonawanda, N. Y. Fibrous material; furnished in sheet form for machining or stamping into parts; flexible; dielectric strength 300 volts per mil; heat resistance 220 degrees Fahr.; high polish; corrosion resistant; tensile strength 8000-16,000 lbs. per sq. in.; resistant to shock. Used for applications where flexibility and toughness in both grain directions are essential.

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STYRON A-50 and A-200—The Dow Chemical Co., Midland, Mich. Thermoplastic; furnished in powder for molding; abrasion resistant, high clarity; corrosion resistant; dielectric strength 5000 volts per mil at 1 mil, 500 volts per mil at 125 mil; tensile strength, ult., to 10,000 lbs. per sq. in.; low moisture absorption; nonflammable; available in color; transparent. Used for insulators, decorative articles, structural parts, etc.

See advertisement, Page 15-D

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SYNTHANE—Synthane Corp., Oaks, Pa.

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Grades C and C-CR; Phenolic; thermosetting; furnished in laminated sheets, and rods or tubes for molding, machining, stamping and sawing into parts; abrasion and corrosion resistant; dielectric strength 200 volts per mil (1/16-inch thickness); tensile strength 9500 lbs. per sq. in.; heat resistance 250 degrees Fahr.; low moisture absorption; nonflammable; shatterproof; specific gravity 1.36. Used for gears, cams, structural parts, rollers, valve disks, corrosion resistant piping, gaskets and thrust washers.

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Grade XX; Phenolic; thermosetting; furnished in laminated sheets, rods or tubes for machining, stamping and sawing into parts; abrasion and corrosion resistant; dielectric strength 700 volts per mil; tensile strength 8000 lbs. per sq. in.; heat resistance 250-300 degrees Fahr.; low moisture absorption; shatterproof; specific gravity 1.36. Used for radio panels, coil forms, switch and relay parts, lead-in bushings, terminal blocks and insulating parts.

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Grade XP; Phenolic; thermosetting; furnished in laminated sheets for machining, stamping and sawing into parts; abrasion resistant; not as corrosion resistant as foregoing grades; dielectric strength 700 volts per mil; tensile strength 8000 lbs. per sq. in.; heat resistance 250 degrees Fahr.; used for radio switch part punchings, condenser stator brackets, washers and relay insulation punchings.

See advertisement, Page 55-D

T

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TAYLOR FIBRE — Taylor Fibre Co., Norristown, Pa. Phenolic base, thermosetting; furnished in laminated sheet, rods or tubes for machining into parts; high polish; flexural strength 12,000-16,000 lbs. per sq. in.; dielectric strength 500 volts per mil; tensile strength 5000-9000 lbs. per sq. in.; heat resistance 300 deg. Fahr.; low moisture absorption; available in colors; impact resistant; brinell hardness 35-45. Used for gears, and insulating and binding material against moderate temperatures.

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TEGIT — Garfield Mfg. Co., Garfield, N. J. Tan colored, cold-molded plastic; corrosion resistant; high dielectric strength; low moisture absorption; heat resistance 300 degrees Fahr.; impact resistant; resists hot oil, boiling water and ordinary chemicals; will not shrink, crack, warp or deteriorate with age. Used for wiring devices and small insulated parts.

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TENITE—Tennessee Eastman Corp., Kingsport, Tenn.

I; cellulose acetate base, thermoplastic; furnished in granular and molding sheet form; available in clear transparent and colors, plain, variegated, translucent and opaque; high impact strength; high polish. Used for compression and injection molding decorative and industrial products, also extruded in form of strips, rods and tubes.

II; cellulose acetate butyrate base, thermoplastic; furnished in granular and molding sheet form; has greater dimensional stability than cellulose acetate plastic because of lower moisture absorption; contains less plasticizer than cellulose acetate plastic and the plasticizer used has greater retentivity; available in clear transparent and colors; plain, variegated, translucent and opaque; high impact strength; high polish. Used for compression and injection molding of decorative and industrial products, also extruded in form of strips, rods and tubes.

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TEXTOLITE — General Electric Co., Plastics Dept., Pittsfield, Mass. Phenolic, urea, ethenna, cellulose bases, thermosetting and thermoplastic materials; furnished in sheets, laminated forms, and rods or tubes; compression and injection molded, machined and stamped into parts; abrasion and corrosion resistant; tensile strength, 3500-20,000 lbs. per sq. in.; dielectric strength 60-1000 volts per mil; heat resistance 140-450 degrees Fahr.; resistant to shock; flexible in some grades; available in color; takes high polish; translucent in some grades; specific gravity 1.07-2.03. Used for electrical or thermal insulation, structural parts, gears, cams, bearings, housings, knobs, decorative parts, etc.

1 2 - 4 - - - - - -

Cold Molded—Two types: nonrefractory material containing asphalt as a binder and asbestos as a filler and refractory containing cement and drying oils as a binder with an asbestos filler; cold molded at room temperatures and heat treated for strength and toughness; corrosion resistant; heat and arc resistant. Not recommended for

1—*Corrosion resistant;* 2—*High heat resistant;* 3—*Impact resistant;* 4—*High tensile strength;* 5—*High dielectric strength;* 6—*Nonflammable;* 7—*Takes high polish;* 8—*Translucent;* 9—*Available in colors;* 10—*Low moisture absorption* parts requiring high electric strength or thin sections.

See advertisement, Page 59-D

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THERMOPLAX—Cutler-Hammer, Inc., Milwaukee. Bituminous base compounded with filler such as asbestos; cold-molded into parts; heat resistance 400-600 degrees Fahr.; nonflammable; dielectric strength 80-100 volts per mil; resistant to corrosion; high polish; tensile strength 2000-4000 lbs. per sq. in.; moisture absorption 2 per cent. Used for electrical and heat insulation.

1 - 3 - - - - - 9 -

THIOKOL—Thiokol Corp., Trenton, N. J. Synthetic rubber, available in two types; furnished in powder or raw sheet form, corresponding to crude rubber; processed in manner similar to rubber; oil, corrosion and shock resistant. Used for hoses carrying oil or gasoline, gaskets, packing, pipeline rings, diaphragms, newspaper printing blankets, etc.

1 2 - - - 6 - - - -

TRANSITE—Johns-Manville, New York. Fireproof material in a variety of forms as hoods, dampers, baffles, electrical conduits where high dielectric strength is not required; resistant to corrosion; heat resistant; nonflammable.

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TYGON—United States Stoneware Co., Akron, O. Resinous thermoplastic; furnished in sheet, rod or tube form, for molding and extruding into parts; abrasion, heat, impact, and corrosion resistant; flexible; high dielectric and tensile strength; low moisture absorption; available in color; shatterproof; translucent. For use in oil and corrosion resistant coverings, gaskets, tubing, etc.

U

1 - 3 - 5 - - - - -

UNISORB—Felters Co. Inc., Boston. Specially controlled felt for vibration absorption. Types and thicknesses available for most frequencies and loadings encountered in industrial field. Also types available for sound absorption. Petroleum resistant. A special brand cement is also available for use with this material in order to eliminate the need of any other form of hold down such as expansion bolts or lag screws. Holding strength in excess of 40 lbs. per sq. in. when used between the felt and steel, concrete or wood.

See advertisement, Page 69-D

V

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VIBRACORK—Armstrong Cork Co., Lancaster, Pa. Resilient board of cork granules; compressed and baked under pressure; long life and high resistance to deterioration. Material is made in three densities for vibration damping applications.

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VIBRO-PLATE—Korfund Co. Inc., Long Island City, N. Y. Material has permanent elastic core, consisting of a combination of several resilient elements; corrosion and shock resistant; low moisture absorption. Used for pads to be placed under legs or bases of machines.

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VICTOPAC—Victor Mfg. & Gasket Co., Chicago. Laminated sheet packing with asbestos base for stamping or cutting by hand into parts; high corrosion resistance; flexibility; tensile strength 2500 lbs. per sq. in.; heat resistant; low moisture absorption; nonflammable; impact resistant; high compressive strength. Used for gasketing and packing.

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VICTOPRENE—Victor Mfg. & Gasket Co., Chicago. Synthetic plastic, thermosetting; furnished in sheet or laminated form, for molding, stamping and blanking into parts; corrosion and heat resistant; tensile strength 1500 lbs. per sq. in.; low moisture absorption; shatterproof. Used as a gasketing material.

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VICTOR—Victor Mfg. & Gasket Co., Chicago.

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Asbestos sheet, asbestos fiber base; furnished in sheets for stamping or cutting into parts; corrosion resistant; flexible; tensile strength 300 lbs. per sq. in.; heat resistance 700 degrees Fahr.; nonflammable; specific gravity .9; high compressive strength; insoluble; some resilience. Used for packing, thermal insulation, and vibration absorption.

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Cork sheet; vegetable bark in sheet form for stamping and cutting into parts; corrosion resistant; flexible; heat resistance 180 degrees Fahr.; low moisture absorption; specific gravity .27; fair compressive strength; resilient. Used for fluid seals and vibration absorption.

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VICTORITE—Victor Mfg. & Gasket Co., Chicago. Vegetable fiber base, sheet packing; furnished for stamping or cutting by hand into machine parts; flexible; tensile strength 3000 lbs. per sq. in.; heat resistance 200 degrees Fahr.; nonflammable; impact resistant; specific gravity .675; compressive strength 2000 lbs. per sq. in.; resilient. Used for gasketing and packing.

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VINYLITE—Carbide & Carbon Chemicals Corp., New York. Unfilled V Series: conjoint polymer of vinyl chloride and vinyl acetate; thermoplastic; furnished in sheets, rods or tubes and powder for molding, machining, heat forming, stamping or extruding into parts; corrosion resistant; takes high polish; flexible; available in colors; nonflammable; moderate tensile strength; dielectric strength 650 volts per mil. Used for machine cabinets, electrical fixtures, transparent windows, dials, drawing and calculating instruments, sound recording disks, etc.

Resins: Series "A" (polyvinyl acetates) in granular form, thermoplastic. Adhesives applied by solution for metal to metal, metal to glass, etc. Series "X" (polyvinyl acetal) in powder and sheet form, thermoplastic. Laminating film for safety glass.

Series "Q" (polyvinyl chloride) in powder form.

1 2 - - - 6 - - - -

VITRIC-10—United States Stoneware Co., Akron, O. Ceramic base, nonplastic; furnished in powder form for casting into parts, or as complete parts; corrosion and heat resistant (1000 degrees Fahr.); nonflammable; compressive strength 3500 lbs. per sq. in.; dielectric strength 40 volts per mil; available in colors. Used for cementing and sealing.

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VULCABESTON—Colt's Patent Fire Arms Mfg. Co., Hartford, Conn. Hard rubber, or Neoprene and asbestos base, thermosetting; furnished in sheet and laminated forms or rods and tubes for machining into parts or supplied as complete parts; heat resistance 750 degrees Fahr.; tensile strength 7000 lbs. per sq. in.; dielectric strength 40 volts per mil; corrosion resistant; low moisture absorption. Uses include insulation, brake linings, valve disks, gaskets, packings, etc.

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VULCOID — Continental-Diamond Fibre Co., Newark, Del. Resinous base, thermoplastic; furnished in sheets and laminated forms, or rods and tubes for machining, stamping or forming into parts; low moisture absorption; dielectric strength 400 volts per mil; tensile strength 11,000 lbs. per sq. in.; resistant to abrasion; flexible in some forms; heat resistant 275 degrees Fahr.; available in red, gray, black; nonflammable; shatterproof. Used for electrical insulation where arc resistance is important. For mechanical insulation where moderate moisture resistance is important.

W

- 2 - - - 6 - - - -

WESTFELT—Western Felt Works, Chicago. Felt material; furnished in cut shapes according to user's specifications; for vibration dampening, deadening sound, insulating against heat and cold and filtering liquids, air and gases; also furnished as oil or dust seals for bearings.

See advertisement, Page 75-D

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WESTFELTOPAK—Western Felt Works, Chicago. Gasketing material made of high grade resilient felt, coated all sides with synthetic rubber, resistant to many mineral oils, gasoline, petroleum hydrocarbons, chlorinated solvents, alcohols and dilute acids and alkalis. Recommended maximum temperature 175 degrees Fahr.

See advertisement, Page 75-D

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WILMINGTON FIBRE—Wilmington Fibre Specialty Co., Wilmington, Del. Cotton rag and paper, chemically treated, nonplastic material; furnished in sheet form or rods and tubes for machining or stamping into parts; dielectric strength 200-400 volts per mil; tensile strength 12,000-15,000 lbs. per sq. in.; resistant to shock and corrosion; high polish; available in colors. Used for electrical and mechanical insulation.

1—Corrosion resistant; 2—High heat resistant; 3—Impact resistant; 4—High tensile strength; 5—High dielectric strength; 6—Nonflammable; 7—Takes high polish; 8—Translucent; 9—Available in colors; 10—Low moisture absorption

Alphabetical Listing of Producers of Design Materials

Section I—Iron, Steel and Nonferrous Metals

A

Acme Steel Co., 2840 Archer Ave., Chicago.
Colored strip steel—ACME COLORSTRIP

Allegheny Ludlum Steel Corp., Oliver Bldg., Pittsburgh.
Stainless steels—ALLEGHENY METAL
Special alloy tool steels—ATLAS No. 93, PYTHON, SEMINOLE, TETON
Nondeforming tool steel—DEWARD
Carbon tool steel—POMPTON
Abrasion resistant alloys—DRAGON, TIOGA
Electrical steels — ALLEGHENY-LUDLUM, MUMETAL and OHMALOY
Mild and stainless steel—PLURAMELT

Allied Process Corp., 444 Madison Ave., New York.
Brass base alloy—AETERNA 600 METAL

Alloy Cast Steel Co., Marion, O.
Cast alloy steels—CAST ALLOY STEELS

Aluminum Co. of America, 634 Gulf Bldg., Pittsburgh.
Aluminum alloys—ALCOA
Aluminum casting alloys—LYNITE
See advertisement, Page 13-D

Aluminum Industries Inc., 2438 Beekman St., Cincinnati.
Aluminum base alloys—PERMITE

American Brass Co., Waterbury, Conn.
Aluminum brass alloy—AMBRALOY
Copper-aluminum alloy—AVIALITE
Copper, aluminum and nickel alloy — TEMPALOY
Corrosion resistant alloys—AMBRAC, TOBIN BRONZE, ANACONDA, EVERDUR

American Magnesium Corp., 2210 Harvard Ave., Cleveland.
Magnesium alloy—MAZLO
See advertisement, Page 4-D

American Manganese Steel Div., The American Brake Shoe & Foundry Co., Chicago Heights, Ill.
Cast steels and welding rods—AMSCO
Manganese steel—MANDENSITE
See advertisement, Page 67-D

American Nickeloid Co., 23 Second St., Peru, Ill.
Refinished bonded sheet and strip—NICKELOID, CHROMALOID, BRASSOID, COPPEROID, AMERICAN BONDED METALS, NICKEL ALUMINUM and CHROME ALUMINUM

American Rolling Mill Co., Middletown, O.
Stainless and high tensile steels—ARMCO
High silicon steel—ARMCO TRAN-COR 60
Pure iron—ARMCO Ingot Iron
Galvanized sheet iron or steel—ZINCGRIP

American Smelting & Refining Co., Equitable Bldg., New York.
Cadmium-nickel bearing alloy—ASARCOLOY NO. 7

American Steel Foundries, 410 N. Michigan Ave., Chicago.
High strength cast steel—HYLASTIC

American Steel & Wire Co., Rockefeller Bldg., Cleveland.
Carbon steels and alloys—AMERICAN QUALITY
See advertisement, Page 17-D

Ampco Metal Inc., 3830 West Burnham St., Milwaukee.
Corrosion and shock resistant alloys—AMPCO METAL
Copper base alloys—AMPCOLOY
See advertisement, Page 3-D

Amplex Mfg. Co., Div. of Chrysler Corp., 6500 Harper Ave., Detroit.
(See Chrysler Corp.)

Anchor Drawn Steel Co., Latrobe, Pa.
High carbon steel—RED ANCHOR

Apollo Steel Co., Apollo, Pa.
Copper-bearing steel—APOLLOY METAL

Aurora Metal Co., 614 West Park Ave., Aurora, Ill.
Aluminum bronze alloy—AUROMET

B

Babcock & Wilcox Co., 19 Rector St., New York.
Corrosion and heat resisting alloys—ADAMANTINE, ELVERITE

Babcock & Wilcox Tube Co., Beaver Falls, Pa.
Corrosion and heat resisting steel tubes—B & W CROLOY

Baker & Co. Inc., 54 Austin St., Newark, N. J.
Platinum alloy—BAKER, PLATINUMCLAD

Beckett Bronze Co., Muncie, Ind.
High lead bronze—BECKETT METAL

Belle City Malleable Iron Co., Racine, Wis.
Pearlitic malleable iron—BELMALLOY
High strength malleable iron—BELECTROMAL
Electric furnace melted cast iron—BELECTRIC

Bethlehem Steel Co., Bethlehem, Pa.
Corrosion resistant alloy steels—BETHADUR
Copper bearing steel—BETH-CU-LOY
Stainless steel—BETHALON
High carbon, manganese and nickel steels; and chromium-molybdenum steel castings—BETHLEHEM
High temperature alloy steel—SUPERTEMP
Nickel-chromium steels—MAYARI

Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
Alloy cast steels—BIRDSBORO

Bishop, J., & Co. Platinum Works, Malvern, Pa.
Stainless seamless tubing—BISHOP

Bohn Aluminum & Brass Corp., Lafayette Bldg., Detroit.
Light aluminum alloy—BOHNALITE

Bound Brook Oil-less Bearing Co., Bound Brook, N. J.
Bearing bronzes—BOUND BROOK, COMPO
See advertisement, Page 59-D

Bridgeport Brass Co., Bridgeport, Conn.
High copper silicon bronzes—DURONZE
Copper and zinc alloys—BRIDGEPORT

Buckeye Brass & Mfg. Co., 6410 Hawthorne, Cleveland.
Bearing bronzes—COMMERCIAL, HYSPEED, LUBRICO
See advertisement, Page 12-D

Buffalo Foundry & Machine Co., Buffalo.
Corrosion and heat resistant alloy—BUFLOKAST

Bunting Brass & Bronze Co., Spencer and Carlton Sts., Toledo, O.
Bearing bronzes—BUNTING
See advertisement, Page 18-D

Burgess-Parr Co., Freeport, Ill.
Acid resisting alloy—ILLIUM

C

Cadman, A. W., Mfg. Co., 2816 Smallman St., Pittsburgh.
Nickel bronze alloy—NICUITE
Babbitt metal—PEARITE, ACORN
Copper alloy—CUPALOY

Campbell, Wyant & Cannon Foundry Co., Muskegon Heights, Mich.
High strength cast irons — CANNONITE, PROFERALL

Cannon-Stein Steel Corp., Marcellus and Wyoming Sts., Syracuse, N. Y.
Manganese and chromium nickel steels—RITA
Corrosion and heat resistant alloy—CANNON
3½ per cent nickel steel

Carboloy Co. Inc., 2985 E. Jefferson Ave., Detroit.
Cemented carbide—CARBOLOY
See advertisement, Page 77-D

Carnegie-Illinois Steel Corp., Carnegie Bldg., Pittsburgh.
Abrasion resisting alloy—U. S. S. AR STEEL, U. S. S. CARILLOY, U. S. S. COR-TEN, U. S. S. MAN-TEN.
See advertisement, Page 17-D

Carpenter Steel Co., Reading, Pa.
Carbon, chromium and chromium nickel steels—CARPENTER

Cerro de Pasco Copper Corp., 44 Wall St., New York.
Bismuth-lead-tin-antimony castings — CERROMATRIX, CERROBASE, CERROBEND

Chace, W. M., Co., 1614 Beard Ave., Detroit.
Thermostatic metal—CHACE THERMOSTATIC METAL

Chain Belt Co., 1604 W. Bruce St., Milwaukee.
High-tensile, corrosion-resistant alloy—REX Z METAL

Chambersburg Engineering Co., Chambersburg, Pa.
Nickel-molybdenum iron alloys—CECOLLOY, CECOLLOY IRON

Chase Brass & Copper Co., Waterbury, Conn.
Corrosion resistant copper alloys—OLYMPIC BRONZE, ANTIMONIAL ADMIRALTY, CHAMET BRONZE, CHASE 444 BRONZE, CHASE and TELLURIUM COPPER

Chrysler Corp., Amplex Div., 6500 Harper Ave., Detroit.
Bearing bronze—OILITE

Cinaudagraph Corp., Stamford, Conn.
Nickel-aluminum-iron alloy—NIPERMAG

Cleveland Twist Drill Co., The, 1242 East 49th St., Cleveland.
High speed steel—MO-MAX

Climax Molybdenum Co., 500 Fifth Ave., New York.
Molybdenum steel—MO-LYB-DEN-UM
See advertisement, Page 63-D

Colonial Alloys Co., Colonial Philadelphia Bldg., Philadelphia.
Corrosion resistant alloy—COLALLOY

Columbia Steel & Shafting Co., Woodkrik St., Pittsburgh, Pa.
High tensile steel—COLUMBIA

Continental Roll & Steel Foundry Co., East Chicago, Ind.
Hard alloys for rolls—DUQUESNE SPECIAL, CROMONITE, HUBBARD SPECIAL, CRASFLOY
Alloy cast steels—DYNAMIC STEEL, TEMP ALLOY

Cooper Alloy Foundry Co., 150 Broadway, Elizabeth, N. J.
Corrosion and heat resisting—COOPER ALLOY

Copperweld Steel Co., Glassport, Pa.
Bearing alloy—ARISTOLOY

Cramp Brass & Iron Foundries Co., Philadelphia.
Copper alloys—CRAMP ALLOYS

Crucible Steel Co. of America, 405 Lexington Ave., New York.
High strength alloy steels—DUPLEX, MAX-EL and SIMPLEX
Corrosion and heat resistant alloys—LO CRO 46, RESISTAL and NITRALLOY 135

D

Detroit Alloy Steel Co., Ft. of Iron St., Detroit.
Alloy steel castings—KROKOLOY, CASTALOY, MARTIN STEEL, FLAMALOY
Oil hardening steel castings—CARBOMANG

Doehler Die Casting Co., 386 Fourth Ave., New York.
Copper-zinc-silicon alloys — DOLER-BRASS, DOLER-ZINK
Magnesium base alloys—DOLER-MAG
Aluminum base die castings—DOLER-ALUMIN

Delloy Metals, 1812 Russell St., Philadelphia.
Wear resistant alloy—DELLOY

Dole Valve Co., The, 1901 Carroll Ave., Chicago.
Thermostatic bimetal—DOLE

Dow Chemical Co., Midland, Mich.
Corrosion resistant light alloys—DOWMETAL
See advertisement, Page 15-D

Driver-Harris Co., Harrison, N. J.
Corrosion, heat and wear resisting alloys — ADVANCE, NIREX, NILVAR, CHROMAX, CIMET, NICHROME, HYTEMCO, DRIVER-HARRIS 42 and 52 ALLOYS

Driver, Wilbur B., Co., Riverside Ave., Newark, N. J.
Nickel copper alloy—CUPRON
Nickel-chromium-iron—CROMIN D
Heat resistant wire—TOPHET

Duriron Co. Inc., Dayton, O. (and licensees—see Duriron in tradename listing).
Corrosion and heat resistant alloys—ALCUMITE, DURICHLOR, DURIMET, DURIRON, DURCO

E

Electro Metallurgical Sales Corp., 30 East 42nd St., New York.
Ferro-alloy—ELECTROMET

Erie Malleable Iron Co., Erie, Pa.
Abrasion and wear resisting malleable iron—ERMAL, ERMALITE

F

Farrell-Cheek Steel Co., Sandusky, O.
Abrasion resisting cast steel—FARRELL's 85, FARRELLS's HARD EDGE

Federal Mogul Corp., 11031 Shoemaker Ave., Detroit.
Bearing bronzes—FEDERAL MOGUL
Babbitt bearing alloys—MOGUL
Lead base babbitt—BERMAX

Ferrous Metals Corp., 444 Madison Ave., New York.
High abrasion resistant alloy—Z-METAL

Firth-Sterling Steel Co., McKeesport, Pa.
Carbon tool steels—STERLING
Cemented carbides—FIRTHITE
Sintered carbide—FIRTHALOY
Stainless steels—STERLING-NIROSTA

Foote Bros. Gear & Machine Co., 5301 S. Western Ave., Chicago.
Nickel-molybdenum alloy—FIVEPOINT DEEP-HARD STEEL

Frank Foundries Corp., Moline, Ill.
Corrosion-abrasion resistant alloys—FRANKITE

Frontier Bronze Corp., 818 Elmwood Ave., Niagara Falls, N. Y.
Heat-resisting alloys—FRONTIER
Titanium-copper alloy—TI-COPPER NO. 39

G

General Alloys Co., 367-405 W. First St., Boston.
Corrosion, heat and wear resisting alloys—X-ITE, X-7, Q-ALLOYS, ECONOMET

General Electric Co., Schenectady, N. Y. (and licensees—see Alnico in tradename listing).
Magnet alloy—ALNICO
Welding electrode—TRODALOY NO. 1

General Plate Div., Metals & Controls Corp., Attleboro, Mass.
Thermostatic metals—TRUFLEX

Gibson Electric Co., 585 Blvd. of the Allies, Pittsburgh.
High ductility alloy—GIBSILOY

Globe Steel Tubes Co., Milwaukee.
Seamless steel tubing—GLOBE

Great Lakes Steel Corp., Div. of National Steel Corp., Ecorse, Detroit, Mich.
Impact-resistant alloy—DUCTILOY
High tensile alloy—N-A-X

H

Halcomb Steel Div., Crucible Steel Co. of America, Syracuse, N. Y.
Stainless steels—HALCOMB

Handy & Harman, 82 Fulton St., New York.
Brazing alloys — HANDY FLUX, SILFOS, EASY-FLO

Haynes Stellite Co., 205 E. 42nd St., New York.
Heat and wear resistant alloys—HAYSTELLITE, HAYNES STELLITE, HASCROME
Corrosion resistant alloy—HASTELLOY, HAYNES 93

Heppenstall Co., Hatfield St., Pittsburgh.
Abrasion resistant alloy steels — HARDTEM, KLEENKUT
High strength alloy steel—HEPPENSTALL, HEPPENSTALL 5H50, EIS45
Nickel chrome molybdenum steel—EIS-57

Hoskins Mfg. Co., 4445 Lawton Ave., Detroit.
Heating element alloys—CHROMEL

I

Industrial Steels Inc., East Cambridge, Mass.
Stainless steels and irons — INDUSTRIAL, Nos. 35 and 12, respectively.

Ingersoll Steel & Disc Division, Borg-Warner Corp., 310 S. Michigan Ave., Chicago.
Stainless clad steel—INGACLAD

Inland Steel Co., 38 S. Dearborn St., Chicago.
High strength, corrosion resistant and copper bearing steels and spring steel—INLAND
Abrasion resisting steel—LEDLOY STEELS 10

International Nickel Co. Inc., 67 Wall St., New York (and licensees).
Corrosion, heat and wear resisting alloys-- NI-TENSYLIRON, NI-HARD, NI-RESIST, NICKEL, MONEL, INCONEL
See advertisement, Page 53-D

J

Jeffrey Mfg. Co., The, First Ave. and Big Four railroad, Columbus, O.
High strength malleable irons — PERDURO, SUPERMAL

Jessop Steel Co., Washington, Pa.
Nonmagnetic steel—JESSOP
Stainless clad steel—SILVER-PLY

Johnson Bronze Co., New Castle, Pa.
Bearing metals — JOHNSON, LEDALOYL JSB
See advertisement, Page 9-D

Jones & Laughlin Steel Corp., Jones & Laughlin Bldg., Pittsburgh.
High tensile steel—JAL-TEN
Free machining steel—JALCASE
Forging steel—J & L CORRECT BALANCE

K, L

Koppers Co., Bartlett-Hayward Div., Baltimore.
Bronze alloy—D-H-S BRONZE.

Lake City Malleable Co., 5060 Lakeside Ave., Cleveland.
Malleable iron—SHOCK PROOF

La Salle Steel Co., 150th and Magnolia, Hammond, Ind.
High-tensile alloy—STRESSPROOF

Lebanon Steel Foundry, Lebanon, Pa.
Alloy cast steels—CIRCLE L

Lehigh Babbitt Co., Box 504, Allentown, Pa.
Graphite and babbitt metals—GRAPHO

Lincoln Electric Co., 12818 Coit Rd., Cleveland.
High tensile welding rods — SHIELDARC, LIGHTWELD, MANGANWELD, WEARWELD, HARDWELD, ABRASOWELD, TOOLWELD, AERISWELD, FLEETWELD, STAINWELD, CHROMEWELD, FERROWELD, SOFTWELD, ALUMINWELD, READYWELD, SURFACEWELD, NICKEL-CHROMEWELD, PLANEWELD, TRANSWELD

Linde Air Products Co., 205 42nd St., New York.
Welding rods—OXWELD

Link-Belt Co., 220 S. Belmont Ave., Indianapolis.
Malleable cast iron—PROMAL

Lukens Steel Co., Coatesville, Pa.
Various types of steels—LUKENS

Lumen Bearing Co., 207 Lathrop Ave., Buffalo.
Wear resisting—MACHINEBRONZE
High tin babbitt—STANNUM BABBITT
Lead base bearing babbitt—LOTUS BABBITT
Bearing alloys—LUMEN ALLOYS

M

Mackintosh-Hemphill Co., 901 Bingham St., Pittsburgh.
Wear resisting steel and iron — ADAMITE, ADAMITE IRON
Wear resisting iron—IRALITE
High strength alloy steel — MACHEMPITE "Wearprooft" and plastic rolls.

Magnolia Metal Co., 120 Bayway, Elizabeth, N. J.
Babbitt metal—ADAMANT SUPER-GENUINE BABBITT
Bearing bronze—MAGNOLIA

Mallory, P. R., & Co. Inc., Indianapolis.
Welding electrodes—ELKALOY
Wear resistant alloy—ELKONITE
Copper base alloys—MALLORY

Manganese Steel Forge Co., Allen St. and Butler Ave., Philadelphia.
Forged alloy steel—ROL-MAN

Massillon Steel Casting Co., Massillon, O.
Alloy cast steel—MASSILLON, TIGERLOY
Nitriding steel—NITRALLOY

Maurath Inc., 7301 Union Ave., Cleveland.
Welding rod—MAURATH

McGill Mfg. Co., Valparaiso, Ind.
Corrosion resistant alloys—McGILL

McKenna Metals Co., 1 Lloyd Ave., Latrobe, Pa.
Carbide alloys—KENNAMETAL
See advertisement, Page 75-D

Meehanite Metal Corp., 311 Ross St., Pittsburgh (and licensees—see Meehanite in tradename listing).
Heat resisting alloy—MEEHANITE
See advertisement, Page 79-D

Metal Carbides Corp., Youngstown, O.
Tungsten carbide metal—TALIDE

Metal & Thermit Corp., 120 Broadway, New York.
Welding electrodes—MUREX

Moraine Products Div., General Motors Corp., 1540 Wisconsin Blvd., Dayton, O.
Bearing alloys—DUREX, MORAINE

Morganite Brush Co. Inc., 3302 48th Ave., Long Island City, N. Y.
Carbon-graphite-metal—MORGANITE
See advertisement, Page 73-D

Mueller Brass Co., Port Huron, Mich.
Corrosion resisting alloys—TUFSTUF, MUELLER 600 BRONZE

N

National Alloy Steel Division, Blawnox, Pa.
Corrosion resisting castings—NA, NA-1, NA-2

National Bronze & Aluminum Foundry Co., East 88th and Laisy Ave., Cleveland.
Aluminum alloy—T-1

Why
DRINK
Coca-Cola
ICE COLD

LEADING MANUFACTURERS LIKE MILLS NOVELTY COMPANY

USE THIS EXTRA-TOUGH SPEED FINISH

Alert manufacturers in many industries have found that durable Polymerin* finish offers them important sales and production advantages. Mills Novelty Company, Chicago, is the largest vending machine manufacturer in the world. Mills and other Polymerin users *know* that Polymerin can save production dollars and brings them these benefits:

1 *Polymerin Is Amazingly Durable.* Through the intricate chemical action of polymerization, Polymerin forms a remarkably tough, resistant film. On Mills' Dispenser for Coca-Cola in bottles, and on scores of other metal products, Polymerin stands up under rough treatment, in or out of doors.

2 *Polymerin Adds "Eye Appeal."* Baked hard onto metal, Polymerin's lustrous surface attracts customers' eyes. Beautiful Polymerin, in white and colors, helps to sell refrigerators, stoves, household appliances, bicycles, kitchen cabinets, and scores of other products where beauty, as well as durability, is an important sales factor.

3 *Polymerin Speeds Production.* The original, speed-bake finish, Polymerin has reduced baking schedules from hours to minutes! Polymerin formulations can be used with the infra-red equipment to cut baking times to new lows.

**Reg. U. S. Pat. Off.*

No Nicks on This Cooler for Coca-Cola!

Coin-operated Coolers for Coca-Cola, like this one at the University of Georgia, are finished with extra-tough Polymerin. Mills Novelty Company, maker of these Coolers, knows that the finish it uses must be attractive. It must protect the machine from nicking and chipping. It must not be affected by moisture; it must resist the deteriorating effects of damp cold. Polymerin meets these difficult requirements! In addition, it offers speed-production advantages. Have you investigated Polymerin's money-saving benefits?

THIS NEW BOOKLET TELLS MORE ABOUT POLYMERIN

FREE! "Facts on Polymerin," a brand new booklet showing how Polymerin is being used in many industries, is now available to you. Mail this coupon.

AULT & WIBORG

Polymerin

THE ORIGINAL SPEED-BAKE FINISH

AULT & WIBORG CORPORATION
Dept. M.D.T., 75 Varick St., New York, N. Y.
Please send me "The Facts on Polymerin."
NAME____________________
COMPANY____________________
ADDRESS____________________

National Erie Corp., Erie, Pa.
Steel castings—NELOY

National Lead Co., 111 Broadway, New York.
Babbitt metal for bearings—DUTCH BOY BABBITT, HOYT BABBITT METAL

National Malleable & Steel Castings Co., 10600 Quincy Ave., Cleveland.
Alloy cast steel—NACO
Malleable cast iron—MALLIX
Chromium-manganese-carbon alloy—NUREX

New Jersey Zinc Co., 160 Front St., New York.
Zinc alloy—ZAMAK, ZILLOY
See advertisement, Page 80-D

Nitralloy Corp., 230 Park Ave., New York (and licensees—see Nitralloy in tradename listing).
Nitriding steel—NITRALLOY
See advertisement, Pages 6-D, 7-D

P

Phelps Dodge Copper Products Corp., 40 Wall St., New York.
High tensile silicon bronze—PMG METAL
Copper alloy—PDCP COPPER
Copper-zinc-tin alloys — BLACKSKIN ADMIRALTY, ADMIRALTY METAL, SUPERLOY
Arsenical copper—PHELPS
Aluminum brass—PHELPS

Pioneer Alloy Products Co. Inc., 16601 Euclid Ave., Cleveland.
Nickel-chromium-molybdenum steel—PIONEER METAL

Pittsburgh Steel Co., Grant Bldg., Pittsburgh.
Stainless steels—PITTSBURGH STAINLESS

Horace T. Potts Co., E. Erie Ave. and D St., Philadelphia.
Chromium - molybdenum alloy — ELASTUF, CHRO-MOLY
Chromium-vanadium alloy—ELASTUF TYPE A
Carbon-manganese-silicon abrasion resisting steel—WEARTUF
Manganese type steel—ELASTUF PENN, STRAINFREE ELASTUF PENN
Free-machining case hardening steel—ELASTUF C. H.

Precision Castings Co. Inc., Syracuse, New York.
Aluminum base alloys—PRECISION

R

Randall Graphite Products Corp., 609 W. Lake St., Chicago.
Graphite bronze bearings and bushings—RANDALL
See advertisement, Page 69-D

Republic Steel Corp., Republic Bldg., Cleveland.
Open hearth iron alloy—TONCAN IRON
Stainless and heat resisting alloys—ENDURO
High strength alloy—REPUBLIC
Low-alloy, copper-nickel-molybdenum steel—REPUBLIC DOUBLE STRENGTH
Enameling stock—TONCAN IRON
Copper-bearing steel—U-LOY

Revere Copper & Brass Inc., 230 Park Ave., New York.
Non-magnetic, corrosion resistant, silicon bronze—HERCULOY
Bearing bronze—ROMAN BRONZE.

Rhoades, R. W., Metaline Co., Inc., P. O. Box No. 1, Long Island City, N. Y.
Heat resisting bearing bronze—METALINE

Riverside Metal Co., Riverside, N. J.
Copper-tin-nickel-zinc alloy—RIVERSIDE

Rustless Iron & Steel Corp., 3400 E. Chase St., Baltimore.
Chromium and chromium nickel stainless steels — DEFIRUST, DEFIHEAT, DEFISTAIN, RUSTLESS 17
Hardening type stainless steel—RUSTLESS

Ryerson, Jos. T., & Son Inc., 16th and Rockwell Sts., Chicago.
Specially processed lead base alloys—GLYCO BABBITT
See advertisement, Page 22-D

S

Saginaw Bearing Co., Saginaw, Mich.
Bearing bronzes—SABECO and AGRICOLA
See advertisement, Page 2-D

Sandusky Foundry & Machine Co., Sandusky, O.
Nickel-chromium and molybdenum cast iron alloys—SANDUSKY ALLOY IRON
Bronze, brass and manganese bronze alloys—SANDUSKY BRONZES

Scomet Engineering Co., Carteret, N. J.
Oxygen-free copper—OFHC

Scovill Mfg. Co., Waterbury, Conn.
Copper alloys—ADNIC
Hardware bronze—SCOVILL
Spring material—OREIDE
Copper-lead-zinc alloy—SCOVILL FREE-CUTTING BRASS ROD
Copper-tin-zinc alloy — SCOVILL NAVAL BRASS

Seitzinger's, T. F., & Sons, 900 Ashby, N. W., Atlanta, Ga.
Bearing bronze—DIXOILBRONZ

Shenango-Penn Mold Co., Dover, O.
High strength alloys—SHENANGO-PENN

Sivyer Steel Casting Co., 1675 S. 43rd St., Milwaukee.
Corrosion and heat resisting cast steels—SIVYER
Abrasion resisting cast steel—SIVYER
Alloy cast steels—SIVYER

Standard Alloy Co., 1679 Collamer Ave., Cleveland.
Corrosion and heat resisting alloys—STANDARD-ALLOY

Steel & Tubes Inc., Cleveland.
Copper bearing steel—ELECTRUNITE

Stoody Co., Whittier, Calif.
Wear resisting alloys—STOODITE, STOODITE (Numbered), STOODY (Self-Hardening), SILFRAM, BORIUM

Sumet Corp., 1543 Filmore Ave., Buffalo.
Bronze bearings—SUMET

Summerill Tubing Co., Bridgeport, Montgomery Co., Pa.
Seamless tubing—SUMMERILL

Superior Steel Corp., Carnegie, Pa.
Stainless strip steel—SUPERIOR STAINLESS

T

Taylor-Wharton Iron & Steel Co., High Bridge, N. J.
Corrosion and abrasion resistant alloys—TISCO
Austenitic wear resisting steel—TIMANG

Thomas Steel Co., Warren, O.
Cold rolled strip steel—THOMASTRIP

Timken Steel & Tube Div., The Timken Roller Bearing Co., Canton, O.
Abrasion resistant bearing alloys—GRAPH-TUNG, GRAPH-SIL, GRAPH-MO
Creep resisting alloy steels—DM STEEL, DM-45, SICROMO STEEL
Heat resistant alloys—SILMO, TIMKEN 17-22A

Titanium Alloy Mfg. Co., Niagara Falls, N. Y.
Extra low carbon trimming steel—TAMCO

True Alloys Inc., 1820 Clay St., Detroit.
Aluminum-bronze alloys—TRUALOY

U

Union Drawn Steel Div., Republic Steel Corp., Massillon, O.
Cold drawn steels—UNION
Free-machining steels—UMA

Union Steel Casting Co., 62nd and Butler Sts., Pittsburgh.
Nickel-vanadium steel—UNIVAN

Unitcast Corp., Steel Casting Div., Toledo, O.
Cast steels—TOLEDO ALLOY

United States Graphite Co., Saginaw, Mich.
Bearing bronze—GRAMIX
Graphitic carbon—GRAPHITAR

United States Steel Corp., 434 Fifth Ave., Pittsburgh. (See Carnegie-Illinois Steel Corp.)
Stainless steels, Shelby tubing, castings, and electrical steel sheets—USS
Atmospheric corrosion and abrasion resistant alloys—U.S.S. COR-TEN, and U.S.S. MAN-TEN
See advertisement, Page 17-D

W

Waukesha Foundry Co., North Chicago, Ill.
Copper-base alloy—WAUKESHA

Wellman Bronze & Aluminum Co., 6017 Superior Ave., Cleveland.
Copper-tin-zinc-lead alloys—IDEALOY; ANFRILOY
Aluminum-silicon-titanium alloy—WELLCAST 17S

West Steel Casting Co., 805 E. 70th St., Cleveland.
Molybdenum-vanadium-nickel alloy—CUMLOY
High tensile strength alloy—DURACAST

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Corrosion and heat resisting alloy—KONAL, PHOS-COPPER, K-42-B
Magnetic alloy—HIPERNIK
Gas type metal—KOVAR
Copper base alloy—CUPALOY
Iron-cobalt-alloy—CUFERCO

Wheelock, Lovejoy & Co. Inc., 128 Sidney St., Cambridge, Mass.
Machinery steels—ECONOMO, HYTEN

Wilcox-Rich Div., Eaton Mfg. Co., 9771 French Rd., Detroit.
Corrosion and abrasion resistant alloys—WILRICH, XALOY

Williams, E. A., & Son Inc., 111 Plymouth St., Jersey City, N. J.
Babbitt metals for bearings—CLOVERLEAF BABBITT, DIAMOND G BRONZE, MILL BRASS MIX
Bearing bronzes—WILLIAMS No. 50 ALUMINUM BRONZE

Wilson, H. A., Co., 105 Chestnut St., Newark, N. J.
Thermostatic bimetal—THERMOMETAL, WILSON Contacting Materials
See advertisement, Page 69-D

Wolverine Tube Co., 1411-1491 Central Ave., Detroit.
Tubing—WOLVERINE

Wood, Alan, Steel Co., Conshohocken, Pa.
High strength steel—"AW" DYN-EL
Rolled steel floor plate—"AW"
High impact and fatigue alloy—DYN-EL

Worthington Pump & Machinery Corp., Harrison, N. J.
Corrosion and abrasion resistant alloy—WORTHITE

Y

Youngstown Alloy Casting Corp., Youngstown, O.
High tensile strength—TRANTINYL

Youngstown Sheet & Tube Co., Youngstown, O.
High strength alloy steel—YOLOY

Section II—Plastics and other Nonmetallics

A

American Cyanamid Co., Beetleware Div., 30 Rockefeller Plaza, New York.
Urea formaldehyde plastic—BEETLE

American Felt Co., 315 Fourth Ave., New York.
Felt material—"K" FELT
See advertisement, Page 61-D

American Hard Rubber Co., 11 Mercer St., New York.
Hard rubber—ACE

American Plastics Corp., 50 Union Sq., New York.
Casein plastic—AMEROID

American Products Mfg. Co., Oleander and Dublin Sts., New Orleans.
Cellulose derivative—INCELOID

Armstrong Cork Products Co., Lancaster, Pa.
Cork and synthetic rubber compound—CORPRENE
Resilient board of cork granules—VIBRACORK

American Phenolic Corp., 1250 W. Van Buren St., Chicago.
Phenolic plastic—AMPHENOL

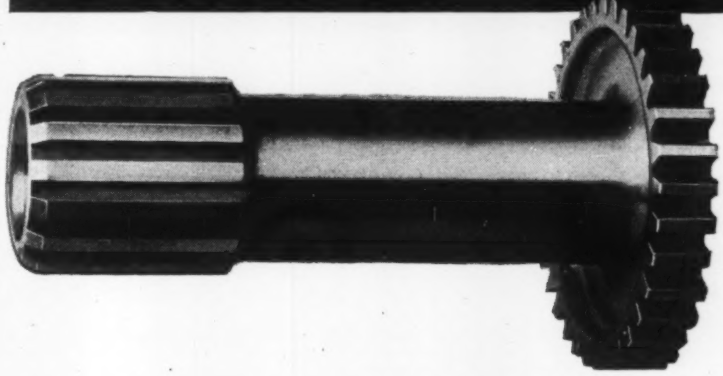
Adding NICKEL TO GEAR STEELS

1—IMPROVES *mechanical properties*
2—SIMPLIFIES *fabricating problems*

PERMISSIBLE COMPRESSIVE STRESSES ON ENGAGED GEAR TEETH

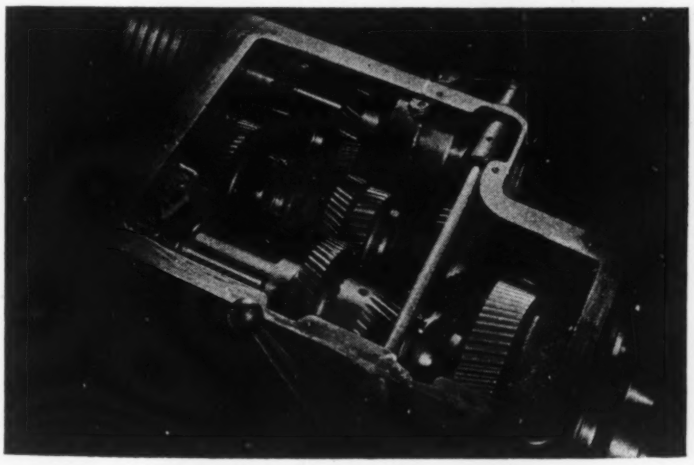
TYPE	NICKEL ALLOY STEELS S.A.E. Classification	PERMISSIBLE COMPRESSIVE STRESS*
Direct Hardening	3150, 4640, 4650, etc.	170,000 lb./sq. in.
Carburizing	3115, 3120	180,000 lb./sq. in.
Carburizing	2315, 2320, 4615, 4620	200,000 lb./sq. in.
Carburizing	3312, 4815, 4820, 2515	215,000 lb./sq. in.

**Compressive stresses calculated from Hertz formula. These values are for intermittently loaded gears and should be reduced 20/25% for constant mesh loading.*



Choosing the most suitable gear steel depends upon getting mechanical properties to safely meet service requirements. But of equal importance are fabricating properties ...uniform response to heat treatment with minimum distortion and freedom from cracking, plus *economical machining.* Today's higher speeds and heavier tooth loadings emphasize the advantages of specifying direct hardening and carburizing gear steels alloyed with Nickel...Nickel alone or in combination.

Hollow quill shaft with integral gear and splines, pictured at left, must be resilient to absorb torque of 500 HP Ranger aircraft engine. To maintain tooth contours and resist fatigue stresses this vital shaft is forged from 3½% Nickel, 1½% chromium steel, SAE 3340.



Strong, tough and wear-resistant, headstock gears in Monarch lathes are 3½% Nickel steel, SAE 2350.

JUST PUBLISHED

"Modern Trends in Nickel Steel and Cast Iron Gear Materials," a paper presented before the American Gear Manufacturers Association 22nd semi-annual meeting. For your copy of this 16-page illustrated booklet, or for personal answers to your gear problems, please address:

THE INTERNATIONAL NICKEL COMPANY, INC.

67 WALL STREET
NEW YORK, N. Y.

Atlas Powder Co., Zapan Div., Stamford, Conn.
Cloth base and Bakelite resinous plastic—REVOLITE

B

Bakelite Corp., 30 E. 42nd St., New York.
Phenolic plastics—BAKELITE

Booth Felt Co., 444—19th St., Brooklyn, N. Y.
Wool base felt—BOOTH FELT
See advertisement, Page 73-D

Bound Brook Oil-less Bearing Co., Bound Brook, N. J.
Material for impregnated wood bushings, etc.—NIGRUM
See advertisement, Page 59-D

Brandywine Fibre Product Co., 1404 Walnut St., Wilmington, Del.
Chemically-treated paper — BRANDYWINE FIBRE

C

Carbide & Carbon Chemicals Corp., 30 E. 42nd St., New York.
Resinous plastic—VINYLITE

Catalin Corp., 1 Park Ave., New York.
Phenolic plastics—CATALIN, PRYSTAL

Celluloid Corp., 290 Ferry St., Newark, N. J.
Cellulose acetate plastic—LUMARITH
Cellulose nitrate plastic—CELLULOID
Cellulose acetate thermoplastic—LUMARITH, PROTECTOID

Chicago Rawhide Mfg. Co., 1301 Elston Ave., Chicago.
Synthetic rubber compounds—SIRVENE
Heat resisting leather—SIRVIS

Colt's Patent Fire Arms Mfg. Co., 17 Van Dyke Ave., Hartford, Conn.
Hard rubber and asbestos base material—VULCABESTON

Continental-Diamond Fibre Co., Newark, Del.
Phenolic plastic—DILECTO, DIAMOND
Resinous plastic — VULCOID, CELLANITE, CELORON
Vulcanized fibre—CODITE
Fibrous, flexible material—MICABOND

Corning Glass Works, Corning, N. Y.
Ceramic base glass—PYREX

Cutler-Hammer Inc., 12th and St. Paul, Milwaukee.
Bituminous plastic—THERMOPLAX
Asbestos base material—PYROPLAX

D

Dow Chemical Co., Midland, Mich.
Plastic granules—ETHOCEL
Cellulose ether base, thermoplastic—ETHOFOIL
Thermoplastic—STYRON
Fibrous thermoplastic—SARAN
See advertisement, Page 15-D

Du Pont de Nemours, E. I., & Co. Inc., Wilmington, Del.
Chloroprene rubber—NEOPRENE
Plastic coated wire mesh—CEL-O-GLASS
Nitrocellulose base—PYRALIN
Polymethyl-methacrylate base—LUCITE
Cellulose acetate base—PLASTACELE
Polyvinyl alcohol—PVA
See advertisement, Page 8-D

Durez Plastics & Chemicals Inc., North Tonawanda, N. Y.
Phenolic plastic—DUREZ

Durite Plastics Inc., Div. of Stokes & Smith Co., 5000 Summerdale Ave., Philadelphia.
Phenol-furfural plastic—DURITE

F

Farley & Loetscher Mfg. Co., Dubuque, Iowa.
Phenolic and urea plastic—FARLITE
Fibrous core with laminated Bakelite surface—FARLOEX

Felters Co. Inc., 210 South St., Boston.
Laminated felt—DUFELT
Felt for vibration isolation, etc.—UNISORB
Felt for grease & oil retention — FELTERS CERTIFIED FELT
See advertisement, Page 69-D

Formica Insulation Co., 4613 Spring Grove Ave., Cincinnati, O.
Laminated resinous plastic—FORMICA

Franklin Fibre-Lamitex Corp., 190 E. Twelfth St., Wilmington, Del.
Phenolic base, thermosetting material—LAMITEX
Hard vulcanized fiber—FRANKLIN

G

Garfield Mfg. Co., Garfield, N. J.
Thermosetting materials—GUMMON (black); HEMIT (gray-white); TEGIT (brown or black)

General Electric Co., 1 Plastics Ave., Pittsfield, Mass.
Nonrefractory and refractory materials—TEXTOLITE: Two types
See advertisement, Page 59-D

Goodrich, B. F., Co., Akron, O.
Synthetic rubber—KOROSEAL

H

Haskelite Mfg. Corp., 208 Washington St., Chicago.
Waterproof plywood — HASKELITE, PLYMETAL

Haveg Corp., Newark, Del.
Phenolic plastic—HAVEG
Phenol formaldehyde plastic—HAVEGIT

Heresite & Chemical Co., Manitowoc, Wis.
Phenolic resin—HERESITE

Hydrocarbon Chemical & Rubber Co., Akron, O.
Synthetic rubber—AMERIPOL

I

Inceloid Co. Inc., 410 Camp St., New Orleans, La.
Cellulose derivative—INCELOID

Irvington Varnish & Insulator Co., Irvington, N. J.
Thermoplastic—IRV-O-LITE

J

Johns-Manville, 22 E. 40th St., New York.
Diatomaceous silica material—CELITE
Rubbery, asphaltic-asbestos material — AERTITE
Asbestos, fiber, graphite and rubber compound—EEL-SLIP
Weatherproof coating—INSULKOTE
Fireproof material—TRANSITE

K

Keasbey & Mattison Co., Ambler, Pa.
Asbestos materials—HY-TEMP, FEATHERWEIGHT and "C" BOARD

Knight, Maurice A., Kelly Ave., Akron, O.
Depolymerized colloidal resin plastic—PYROFLEX
Corrosion resistant stoneware — KNIGHTWARE

Korfund Co. Inc., 58-15—32nd Place, Long Island City, N. Y.
Finely granulated compressed cork plates—KOMPO-KORK
Resilient mat of pure natural cork—KORFUND
Finely granulated cork and rubber—KORKRUBBER
Permanent elastic cork material — VIBROPLATE

L

Lord Mfg. Co., Erie, Pa.
Rubber bonding—LORD
See advertisement, Page 10-D

Luzerne Rubber Co., Dewey St., Trenton, N. J.
Hard rubber, thermoplastic—LUZERNE HARD RUBBER

Makalot Corp., 262 Washington St., Boston.
Synthetic resin plastic—MAKALOT

M

Marblette Corp., 3721 30th St., Long Island City, N. Y.
Phenolic plastic—MARBLETTE

Monsanto Chemical Co., Plastics Div., Springfield, Mass.
Cellulose nitrate plastic—MONSANTO Cellulose Nitrate
Phenolic plastic—MONSANTO Cast Phenolic, MONSANTO RESINOX
Polyvinyl acetal plastic — MONSANTO BUTVAR, FORMVAR

N

National Carbon Co. Inc., Madison Ave. & W. 117th St., Cleveland.
Carbon or graphite in amorphous or graphitic form—NATIONAL CARBON

National Vulcanized Fibre Co., Wilmington, Del.
Laminated Bakelite—PHENOLITE
Cotton cellulose base, vulcanized fiber—NATIONAL FIBRE, NATIONAL SWITCH INSULATION
Cotton rag base, fish paper insulation—PEERLESS
See advertisement, Page 75-D

O, P

Owens-Corning Fiberglas Corp., Toledo, O.
Glass, in fibrous form—FIBERGLAS

Panelyte Corp., 230 Park Ave., New York.
Synthetic laminated resinous material — PANELYTE

Penn Fibre & Specialty Co., 918 S. Front St., Philadelphia.
Phenol and vulcanized fiber—PENN

Plaskon Co. Inc., 2112 Sylvan Ave., Toledo, O.
Urea formaldehyde plastic — PLASKON, UNYTE

Polaroid Corp., Cambridge, Mass.
Light-polarizing glass—POLAROID

R

Reilly Tar & Chemical Corp., Merchants Bank Bldg., Indianapolis
Phenolic plastic—INDUR, INDUR VARNISH

Resistoflex Corp., Belleville, N. J.
Polyvinyl alcohol plastic—RESISTOFLEX PVA

Richardson Co., The, Melrose Park, Ill.
Thermosetting plastic—INSUROK
Hard rubber—RUB-TEX, RUB-EROK
Acid-resisting bituminous plastic—EBROK
Thermoplastic—MICAROK
See advertisement, Page 14-D

Rohm & Haas Co. Inc., 222 W. Washington Sq., Philadelphia.
Acrylic base plastic—PLEXIGLAS, CRYSTALLITE

Ryerson & Son Inc., Jos. T., 16th and Rockwell Sts., Chicago.
Bearing material—RYERTEX
See advertisement, Page 22-D

S

Self-Vulcanizing Rubber Co. Inc., 605 W. Washington Blvd., Chicago.
Gum rubber base material, in liquid form—AIRVULC
Cold curing gum rubber, liquid form—SELFVULC

Spaulding Fibre Co. Inc., Tonawanda, N. Y.
Fibrous material — SPAULDING FIBRE, SPAULDING ARMITE, SPAULDO
Phenolic plastic—SPAULDITE

Stokes & Smith Co. (Durite Plastics Div.) Philadelphia.
Phenol furfural plastic—DURITE

Synthane Corp., Oaks, Pa.
Laminated Bakelite—SYNTHANE
See advertisement, Page 55-D

T, U

Taylor Fibre Co., Norristown, Pa.
Phenolic base thermosetting material—TAYLOR FIBRE

Tennessee Eastman Corp., Kingsport, Tenn.
Cellulose acetate plastic—TENITE

Thiokol Corp., Trenton, N. J.
Synthetic rubber—THIOKOL

United States Stoneware Co., Akron, O.
Ceramic base, nonplastic—VITRIC-10
Resinous thermoplastics—RESILON, TYGON

V

Victor Mfg. & Gasket Co., 5750 Roosevelt Rd., Chicago.
Laminated sheet packing—VICTOPAC
Vegetable fiber base sheet packing—VICTORITE
Asbestos sheet—VICTOR
Cork sheet—VICTOR
Mineral base asbestos—ASBESTOPRENE
Synthetic resin—VICTROPRENE

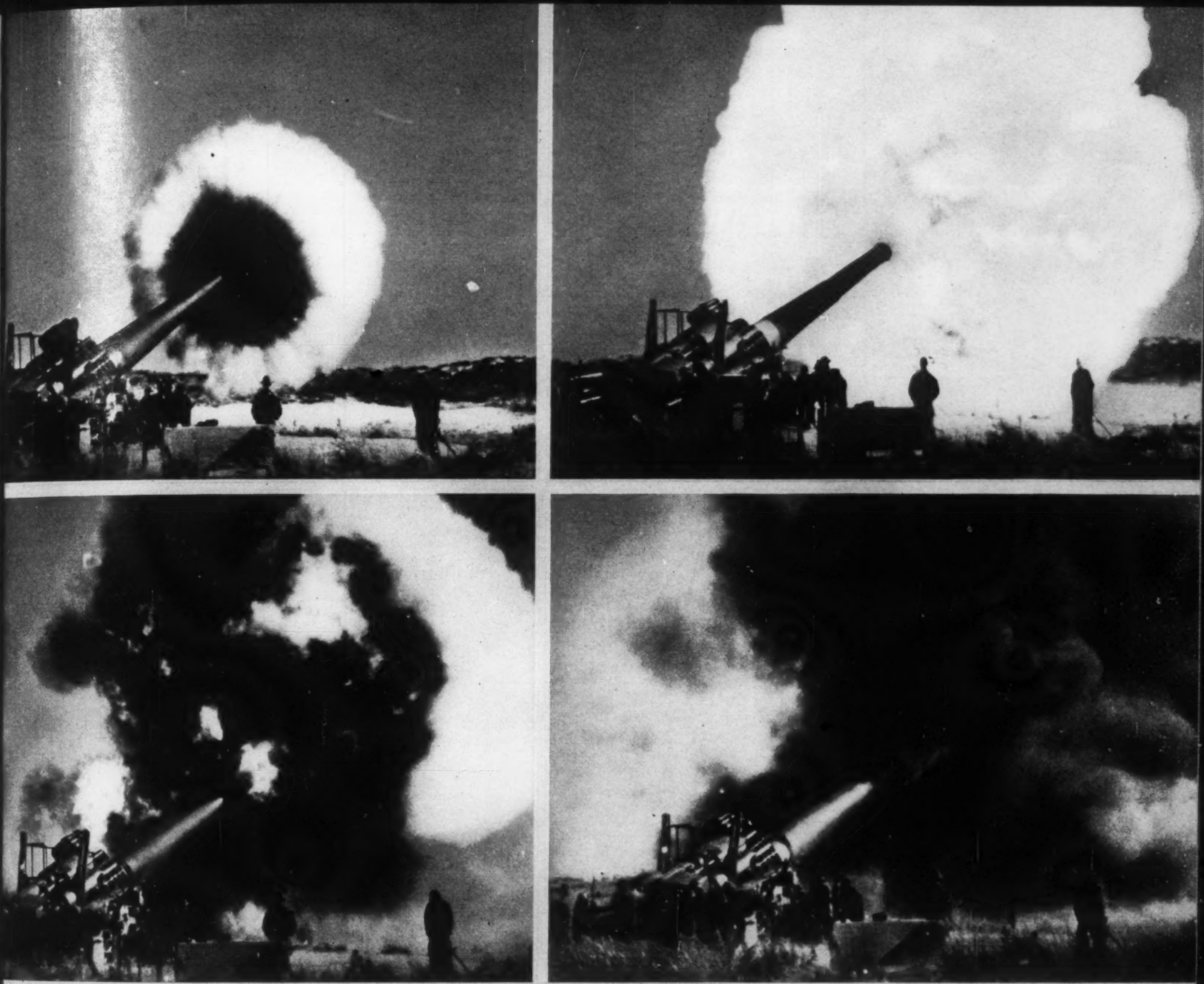
W

Watertown Mfg. Co., Watertown, Conn.
Phenolic plastic—NEILLITE

Western Felt Works, 4117 Ogden St., Chicago.
Felt material — WESTFELT, GASKOFELT, WESTFELTOPAK and RESISTOFELT
See advertisement, Page 75-D

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Phenolic plastic—MICARTA

Wilmington Fibre Specialty Co., Wilmington, Del.
Paper base material—FYBEROID
Cotton rag and paper, nonplastic—WILMINGTON FIBRE
Phenolic plastic—OHMOID



Insulation Tells Them When to Talk

A—Detector Case, turned, threaded, bored, drilled, tapped and counter-bored.

B—Sawed and drilled insulators.

C—Filter bracket, sawed, milled and drilled.

TRAINING, elevating and firing big guns afloat and ashore is a job for electricity and its inseparable co-worker—insulation. And in many types of gun control as in many electrical conveniences that prepare your toast, automobiles that take you to work, machines that tabulate your business figures—you'll find dependable Synthane Bakelite-laminated.

The uses for Synthane are not limited to electrical devices. Synthane has too many combined properties for that. It is a dense, hard, uniform, technical plastic, light in weight (about half the weight of aluminum), structurally strong, and resistant to solvents, gases, petroleum products, many acids and salts. Synthane is also easily machined—or we'll machine it for you as we did for the three manufacturers whose products are shown at the left.

With all these properties—and more—Synthane is worth considering wherever any other material is limited in its properties, harder to machine or giving unsatisfactory performance. We invite you to send for "Technical Plastics in Industry", a folder showing how and where to use Synthane, and to use the services of our men, material and machines in improving your product.

SYNTHANE CORPORATION, OAKS, PENNSYLVANIA

SYNTHANE

Bakelite—S laminated

TECHNICAL PLASTICS

SHEETS · RODS · TUBES · FABRICATED PARTS · SILENT STABILIZED GEAR MATERIAL

Stampings Producers

Reference letters beneath addresses of companies refer to: (a) Types, materials and sizes of stampings; (b) Names of stamped machine parts customarily produced; and (c) Machining, heat treating or assembling facilities.

A

Accurate Spring Mfg. Co., 3811 W. Lake St., Chicago.
(a) Blanking, forming and perforating all metals, small and medium sizes, specializing in spring materials.
(b) To customers' specifications.
(c) Complete facilities.

Ace Hardware Mfg. Corp., The George Jones Co., 2020 E. Orleans St., Philadelphia.
(a) Flat, drawn and formed stampings of all materials, 5-75 tons pressure capacity. Sizes 20 in. square light and heavy gages.
(b) To customers' specifications.
(c) Complete facilities.

Acklin Stamping Co., 1925 Nebraska Ave., Toledo, O.
(a) Pressed metal parts of steel, brass and aluminum to 40 in. dia., .010 to ⅝ in. metal thickness.
(b) To customers' specifications.
(c) Complete facilities.

Adams Metalware Co., S. G., 2947 Delmar Blvd., St. Louis.
(a) Medium deep drawn, large blanked and formed stampings in brass, copper, steel, aluminum, Monel, stainless steel; to 6 in. deep drawn and 30 x 60 blanked and formed.
(b) Vending machines, ice cream cabinets, air conditioning equipment, stokers and automotive parts.
(c) Complete finishing facilities.

Aluminum Goods Mfg. Co., Washington St., Manitowoc, Wis.
(a) Aluminum stampings, spinnings and deep drawings.
(b) Refrigerator, radio, textile, electrical, and automotive parts.
(c) Complete facilities.

American Aluminum Ware Co., 368-378 Jelliff Ave., Newark, N. J.
(a) Aluminum industrial stampings and spinnings.
(b) Pouring spouts, spools, reflectors, boxes, tubes, etc.
(c) None.

American Emblem Co. Inc., Box D 116, Utica, N. Y.
(a) Art metal and intricate stampings up to 16 in. square; .003 to .25-in. metal thickness.
(b) Embossed nameplates, radio escutcheons and dials and ornamental stampings.
(c) Complete facilities.

American Pulley Co., 4200 Wissahickon Ave., Philadelphia.
(a) Pressed steel stampings in light to heavy steel gages; also deep drawn stampings.
(b) To customers' specifications.
(c) Complete facilities.

Amesbury Metal Products Co., Inc., 39 Oakland St., Amesbury, Mass.
(a) Stampings from deep drawn and cold rolled steel, brass, aluminum, nicral and copper.
(b) Automobile and marine lamp equipment. clock cases, vending machine cabinets and mechanisms.
(c) Complete facilities.

Apco Mossberg Co., Attleboro, Mass.
(a) Medium and heavy stampings from .05-.187 in. thick.
(b) To customers' specifications.
(c) Complete facilities.

Auto Sun Products Co., The, 529 Poplar St., Cincinnati.
(a) Small and medium stampings to 5 in. draw, from steel, brass, bronze and aluminum, up to 5/16 in. thick, 16 x 24 in.
(b) Radio, refrigerator, wash machine parts, etc.
(c) Assembling facilities.

B

Barnes-Gibson-Raymond Div., Associated Spring Corp., 6391 Miller Ave., Detroit. (The Cook Plant—Ferry Field and Boulevard drive, Ann Arbor, Mich.)
(a) Small flat springs and stampings from carbon and alloy steels and nonferrous metals.
(b) Special small stampings, formed flat wire parts, catches, clips, contacts, snap rings, retainers and washers.
(c) Complete facilities.

Barth Stamping & Machine Works, 3815 W. 34th St., Cleveland.
(a) Light and medium stampings of steel, brass, aluminum, etc.
(b) To customers' specifications.
(c) Machining facilities.

Bellevue Mfg. Co., The, Bellevue, O.
(a) Deep drawn to 12 in., and general small stampings.
(b) Automotive.
(c) Annealing, enameling, plating and assembling.

Bossert Co. Inc., The, 1002 Oswego St., Utica, N. Y.
(a) Stampings from .005 to 1 in. in thickness, any metal.
(b) Automotive, refrigeration, washing machine, radio, etc.
(c) Assembling and welding facilities.

Brewer-Titchener Corp., The, 111 Port Watson St., Cortland, N. Y.
(a) Flat, formed, and drawn (max. 4 in.) stampings of ferrous and nonferrous, stainless, etc., up to 30 x 60 in. in size and 4 in. max. draw.
(b) To customers' specifications.
(c) Complete facilities.

Bridgeport Chain & Mfg. Co., The, Bridgeport, Conn.
(a) Small flat stampings of steel, brass and bronze, to .065 in. gage, 4 in. length or dia.
(b) To customers' specifications.
(c) Complete facilities.

Budd, Edward G., Mfg. Co., Philadelphia. (Detroit branch located at 13141 Charlevoix Ave.)
(a) Automobile body and small special stainless stampings of mild steel.
(b) Automotive, chemical and rayon, rail cars, commercial trailers, marine and aircraft fields.
(c) Complete facilities.

Buffalo Brake Beam Co., 140 Cedar St., New York.
(a) Small stampings from light bars and strip stock.
(b) To customers' specifications.
(c) Information not available.

C

Chapin, The R. E., Mfg. Works Inc., 29 Liberty St., Batavia, N. Y.
(a) Blanks to 26-in. dia. light gage.
(b) Sprayers, atomizers, pumps.
(c) Machining.

Chase Brass & Copper Co. Inc., 236 Grand St., Waterbury, Conn.
(a) All types sheet metal stampings, drawn shells of brass, copper and copper alloys.
(b) All types of parts.
(c) Machining, polishing, plating and assembling facilities.

City Auto Stamping Co., Lint and Dura Ave., Toledo, O.
(a) Large light-gage stampings.
(b) Automotive.
(c) Assembling facilities.

Cleveland Pressed Steel Co., 2593 E. 55th St., Cleveland.
(a) Small and medium stampings from any material.
(b) Variety of parts.
(c) Adequate facilities.

Cleveland Steel Products Corp., Plant No. 2, Wellington, O.
(a) All types to 12 in. draw, 12 in. dia., ¼ in. thick.
(b) Automotive, radio, industrial and electrical.
(c) Complete secondary operation, cyanide hardening, plating and assembling.

Columbia Metal Stamping Co., The, 11900 Harvard Ave., Cleveland.
(a) Light and medium stampings in all metals to ¼ in. thick, to 24 x 24 in. Deep drawn to 3½ in. deep, ⅛ thick.
(b) Automotive, electrical, industrial and general.
(c) Complete facilities.

Commercial Shearing & Stamping Co., 1775 Logan St., Youngstown, O.
(a) To 60 in., ¾-in. gage, steel and copper alloys, aluminum and stainless steel.
(b) Tank heads and other heater parts.
(c) Machining and assembling facilities.

Cuyahoga Spring Co., The, 10301 Berea Rd., Cleveland.
(a) Stampings of cold-rolled steel, up to No. 10 gage; flat springs stamped or formed and tempered for mechanical purposes; also brass, bronze stampings.
(b) Primarily flat springs.
(c) Complete facilities.

D

Dahlstrom Metallic Door Co., Buffalo St., Jamestown, N. Y.
(a) Steel (stainless), brass, bronze, aluminum stampings and drawn parts. Press equipment Bliss 3-B to 7-E, and brake presses for sections 10 to 12 ft. long.
(b) Machine guards, cabinets, latches, brackets and special parts.
(c) Assembling facilities.

Dayton Rogers Mfg. Co., 2830 S. 13th Ave., Minneapolis.
(a) Stampings of steel, brass, copper, aluminum, Bakelite, and all sheet stock; 24 x 24 in., max. thickness ¼ in.
(b) Adding machines, office equipment, aircraft and various small parts.
(c) Machining and heat treating.
See advertisement, Page 57-D

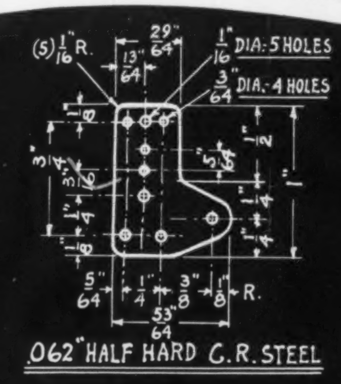
Dellinger Mfg. Co., 725 N. Prince St., Lancaster, Pa.
(a) Small and medium metal stampings of brass, steel and aluminum.
(b) Radio, electrical, farm machinery parts, etc.

Diamond Expansion Bolt Co., Inc., Garwood, N. J.
(a) Blanking, piercing and bending, strip steel, brass, copper and aluminum; from small to capacity of 70-ton press.
(b) Cable straps, toggle bolts, nuts, hammer drive anchors, etc.
(c) Complete facilities.

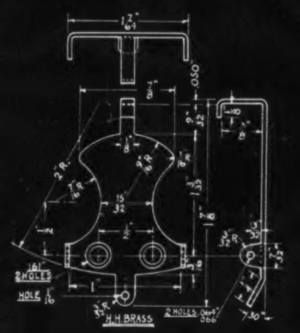
Dill Mfg. Co., The, 700 E. 82nd St., Cleveland.
(a) Small brass and steel stampings.

FORGET DIE COST!

HERE'S A REVOLUTIONARY METAL STAMPING SERVICE THAT ASSURES BIG SAVINGS ON SMALL LOTS . . .



We produced the first 100 of these parts for one of our customers at a cost of only $19.00; additional quantities were produced for $3.25 per 100.



Cost of blanking, piercing and forming the part shown was $32.00 for the first 100; subsequent orders were handled at a cost of $6.00 per 100. There was no extra tool charge.

THERE is no such thing as prohibitive die cost when you put your small lot metal stamping production in the modern Dayton Rogers shop.

Regardless of quantity limitations, intricacy of design or kind of material, Dayton Rogers can produce your stamping requirements faster and cheaper than is possible by ordinary methods which depend on costly dies.

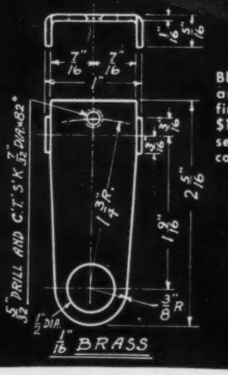
As pioneers in the development of a commercially practical and successful blanking and piercing method for small lot production, and with more than fifteen years' experience on which to draw, Dayton-Rogers not only assures exact duplication of parts, but BIG SAVINGS in time and money.

The examples of Dayton Rogers' service shown here are typical of many others. In all cases Dayton Rogers' customers have been able to effect outstanding economies, with rigid adherence to working tolerances.

Dayton Rogers is prepared to render prompt and efficient cost-cutting service on your requirements by maintaining a complete stock of such metal-stamping materials as sheet steel, strip steel, sheet brass, sheet aluminum, dural, copper, Bakelite, sheet bronze, sheet nickel and aircraft sheet alloys.

● **SEND YOUR SPECIFICATIONS**

Submit your samples or blueprints. Ask us to quote. You'll be convinced that Dayton Rogers offers you outstanding savings.



Blanking, piercing and forming the first 100 parts cost $19.50; each subsequent 100 parts cost $2.80.

In the above costs material price is not included.

DAYTON ROGERS
MANUFACTURING COMPANY
MINNEAPOLIS · MINNESOTA

New York · Cleveland · Chicago

(b) Ferrules, rubber inserts, valves and valve parts, etc.
(c) None.

Douglas & Lomason Co., 5836 Lincoln Ave., Detroit.
(a) Formed-draws up to 300-ton presses of C. R. steel, stainless steel, brass and aluminum, to 18 x 36 in.
(b) Radiator grilles, extension panels, nameplates, instrument board plates, etc.
(c) Machining and assembling facilities.

Duplex Mfg. Corp., Sherman, N. Y.
(a) All type stampings of steel or galvanized sheets, small and large.
(b) Brackets, braces, airplane parts and other small parts.
(c) Complete facilities.

E

Ellis, George D., & Sons Inc., 309 N. 3rd St., Philadelphia.
(a) Tinplate, steel, copper, aluminum and brass stampings, 20 gage and lighter.
(b) All types of machine parts.

Ennen, Geo. L., Co., 7 Emerick St., Ypsilanti, Mich.
(a) Small steel stampings.
(b) Automotive.
(c) None.

Erie Art Metal Co., 18th and Schaal Ave., Erie, Pa.
(a) All types of sheet metal stampings, ferrous and nonferrous.
(b) Metal cabinets built to order, vault boxes, etc.
(c) Complete facilities.

ESMCO Auto Products Corp., 33 34th St., Brooklyn.
(a) Blanking, forming and drawing, light and heavy, as well as intricate stampings of steel to 24 in. sq.
(b) Clutch disks, tubular parts, etc.
(c) Complete facilities.

Eureka Tool & Machine Co., 27 W. 55th St., New York.
(a) Small and medium stampings.
(b) To customers' specifications.
(c) Complete facilities.

F

Falstrom Co., 34 Main Ave., Passaic, N. J.
(a) Shallow stampings of steel, aluminum, copper, etc., press brake 3/16 in. x 10 ft. long, punch press 14 in. gage.
(b) Machine enclosures, streamline steel housings, cabinets, instrument panels, etc.
(c) Machining and assembling facilities.

Firestone Steel Products Co., Akron, O.
(a) Blanking, forming and drawing metal stampings, hot and cold-rolled steel, stainless steel; in small or large sizes.
(b) Automotive and general machine parts.
(c) Information not available.

Fox Co., Fox Bldg., Cincinnati.
(a) Metal stampings.
(b) Nameplates, escutcheons, etc.
(c) Assembly facilities.

G

Geometric Stamping Co., The, 1111 E. 200th St., Cleveland.
(a) Any type stampings in steel, stainless steel, brass, etc., ½ in. thick, 48 x 84 in.
(b) Dairy, washing machine, radio, railroad and automobile parts, etc.
(c) Complete facilities.

Geuder, Paeschke & Frey Co., 324 N. 15th St., Milwaukee.
(a) Deep drawn in all metals to 48 in. dia., 18 in. deep, 12-30 gage.
(b) Business and vending machine cases, tubs for electric washers, switch and transformer cases.
(c) Complete facilities.

Gibson Co., William D., Div. of Associated Spring Corp., 1800 Clybourn Ave., Chicago.
(a) Miscellaneous stampings of cold-rolled spring steel, stainless and alloys, small and medium.
(b) Springs.
(c) Heat treating facilities.

Globe Machine & Stamping Co., 1250 W. 76th St., Cleveland.
(a) Metal stampings of all sizes.
(b) Various types of parts.
(c) Machining and assembling facilities.

Goat, Fred, Co. Inc., The, 314 Dean St., Brooklyn.
(a) Stamped, formed, drawn light sheet metal, steel, stainless steel, nickel, silver, tantalum, Monel, molybdenum, brass, copper, tin plate and zinc; .001 to ⅛ in., 1 to 10,000 per lb.
(b) Special cups, clips, caps, eyelets, etc.
(c) Complete facilities.

Grammes, L. F., & Sons Inc., Allentown, Pa.
(a) Stampings of brass, aluminum, steel, etc.
(b) Automotive, radio, clock and electrical.
(c) Complete facilities.

Gray, Peter, Corp., 290 Third St., Cambridge, Mass.
(a) Steel and nonferrous metals, drawn, stamped and formed, up to 3/16 in. thick x 5 sq. ft. on press work and 8 ft. long on brake work; also deep drawing.
(b) Handles, guards, stop motions, meters, fans, covers, radio, refrigerator casings, propeller heads, and textile machine parts.
(c) Complete assembling and some machining facilities.

Greer, Frederic, Co., 2630 West Flournoy St., Chicago.
(a) Small automatic stampings in any material.
(b) Terminals of all types.
(c) Complete facilities.

Greist Mfg. Co., The, New Haven, Conn.
(a) Small stampings, specializing on forming operations.
(b) Business machine, photographic, electrical, sewing machine parts and assemblies.
(c) Complete facilities.

Griffith-Hope Co., 6607 W. Mitchell St., West Allis, Wis.
(a) Stampings of 30 gage to 10 gage drawn shapes, and shells up to 5 in. in depth.
(b) Paper-dispensing equipment, automobile stampings, etc.
(c) Assembling facilities.

Guth Co., The Edwin F., 2615 Washington Blvd., St. Louis.
(a) Punched and deep drawn stampings of steel, bronze, and brass up to 24 in. dia.
(b) To customers' specifications.
(c) Complete facilities.

H, I

Hagstrom Mfg. Co., 308 W. 19th Terrace, Kansas City, Mo.
(a) Small stampings to 24 in. square, in all metals.
(b) Vending machine, etc.
(c) Machining facilities.

Harvey Machine Co., 6200 Avalon Blvd., Los Angeles.
(a) All kinds of blanking, deep drawing up to 42 x 62 in. bed, in all metals.
(b) All types of machine parts.
(c) Complete facilities.

Hoosier Lamp & Stamping Corp., Evansville, Ind.
(a) Light gage, aluminum, stainless, Monel, brass, etc.
(b) Interior refrigerator parts, etc.
(c) Alumiliting, welding, all finishing and complete assembling.

Hubbard, M. D., Spring Co., Pontiac, Mich.
(a) Small stampings in spring steels, hot and cold-rolled steel, brass, bronze, aluminum, Monel and stainless steel.
(b) Expansion plugs, washers, flat springs and spring washers.
(c) Drilling, tapping, spot welding, and heat treating.

Hunter Pressed Steel Co., Lansdale, Pa.
(a) Various types, including deep drawn stampings, from smallest to ⅛-in. stock, 15 in. blank in all materials.
(b) All types of machine parts.
(c) Complete facilities.

Indiana Pressed Steel Co., Muncie, Ind.
(a) Medium and medium-large stampings in all metals.
(b) Refrigerator, automotive, radio, electrical, etc.
(c) Complete facilities.

K

Karp Metal Products Co. Inc., 129 30th St., Brooklyn, N. Y.
(a) Steel, brass, aluminum, Monel, stainless steel, and other alloy stampings.
(b) Enclosures for electrical and mechanical devices.
(c) Welding facilities.

Kickhaefer Mfg. Co., 901 S. Second St., Milwaukee.
(a) Small and medium stampings of steel, brass, copper and aluminum.
(b) Valve spring washers, special washers, tubing, engine front and rear plates, plugs, etc.
(c) None.

Klein Mfg. Co., Burlington, Ia.
(a) Steel and galvanized iron stampings.
(b) To customers' specifications.
(c) Complete facilities.

L

Laminated Shim Co. Inc., Glenbrook, Conn.
(a) Small, flat, brass, steel, zinc, copper, etc.
(b) Shims.
(c) None.

Lees, John, Div., The Serrick Corp., Muncie, Ind.
(a) Small stampings and mouldings in stainless steel, bronze, and cold-rolled steel.
(b) Various types of machine parts.
(c) Complete facilities.

Lewyt Metal Products Co., 112 60 Broadway, New York.
(a) Sheet metal stamping.
(b) Boxes, housings and cabinets.
(c) Machining and assembling facilities.

Lorentzen Inc., H. K., 391 West Broadway, New York.
(a) Small and medium stampings, .01-.093 in. thickness, in nonferrous and ferrous metals.
(b) Radio parts, chassis, etc.
(c) Spot welding, riveting and assembling facilities.

M

Milcor Steel Co., 4100 W. Burnham St., Milwaukee.
(a) Flat, drawn, formed and intricate stampings of all types, in hot and cold rolled and galvanized sheets, copper, tin, etc., 16 gage to 30 gage; very small to medium large (6 sq. ft. max.)
(b) To customers' specifications.
(c) Complete machining and assembling.

Milwaukee Stamping Co., 800 S. 72nd St., Milwaukee.
(a) Steel, brass, bronze, etc., in thickness of ¼ in., max. draw 4 in., and up to 100-ton capacity.
(b) Specially designed parts.
(c) Complete facilities.

Morrison Products Inc., 16816 Waterloo Rd., Cleveland.
(a) All gages up to ¼ in., deep drawn stampings up to 6 in. deep, in steel and other metals.
(b) All types of machine parts.
(c) Complete assembling, spotwelding, riveting, machining and japanning facilities.

Mullins Mfg. Corp., Warren, O. (Another plant at Salem, O.)
(a) Light and heavy gage stampings, light gage deep drawn stampings from 20 to 16 gage in sizes up to 80 x 160, depth of draw up to 22 in.
(b) Washing machine tubs, steel evaporators, and automobile parts.
(c) None.

Murray Corp. of America, 7700 Russell St., Detroit.
(a) Light and heavy stampings of any type.
(b) Fenders, hoods, frames, grilles and bodies.
(c) None.

N

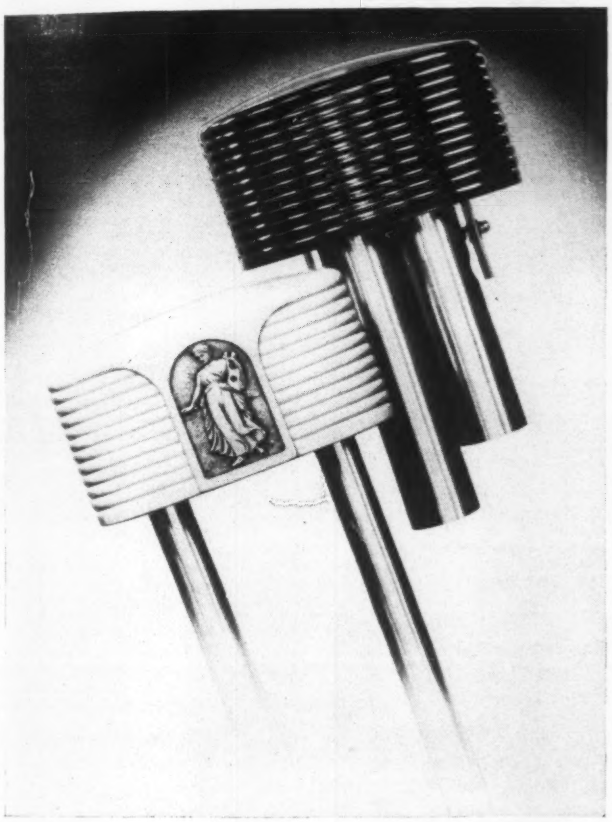
Nagel-Chase Mfg. Co., The, 2811-23 N. Ashland Ave., Chicago.
(a) Pressed steel parts to 11 gage and about 20 in. dia.
(b) Pulleys for V-belts, washing machine casters, etc.
(c) Complete facilities.

New England Pressed Steel Co., Washington Ave., Natick, Mass.
(a) Stampings of steel, brass, copper, stainless steel and aluminum, small and medium.
(b) To customers' specifications.
(c) Heat treating and assembling facilities.

Niles Steel Products Div., Republic Steel Corp., Elyria Works, Elyria, O.
(a) Pressed steel to ½ in. thick.
(b) Automotive, tractor, sweeper, washing machine, etc.
(c) Some machining and assembling facilities.

Noera Mfg. Co., Div. of Chase Brass & Copper Co. Inc., Waterbury, Conn.
(a) Medium and light stampings of copper, brass, aluminum, steel, 14 in. and smaller.

TEXTOLITE MOLDED



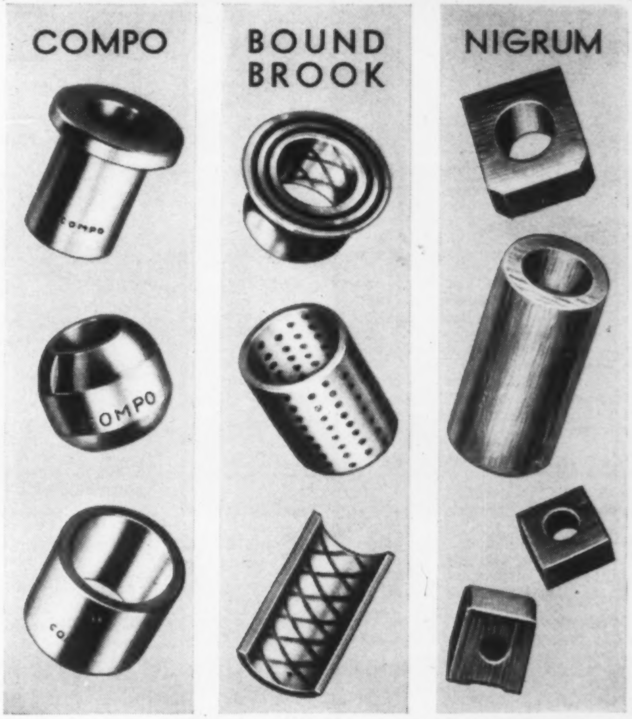
Designed in Textolite the chime housings and bases for the Mello-Chime and Signal Co. of New York are beautiful and mechanically simple. Lower assembly costs, electrical insulation inherent in the material, and a permanent finish are other desirable factors. Write Section A-80, Plastics Department, General Electric Co., One Plastics Avenue, Pittsfield, Mass.

PLASTICS DEPARTMENT

GENERAL ELECTRIC

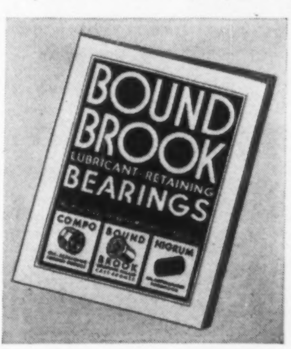
PD-801

FOR BETTER MACHINES AND APPLIANCES



The Big-Three

- COMPO Oil-Retaining Porous Bronze Bearings contain up to 35% of lubricant; made by die-pressing pure metal powders, alloying at high temperatures and finishing to great accuracy; used on thousands of applications.
- BOUND BROOK Cast Phosphor Bronze Bearings, inlaid with enduring graphite lubricant, in grooves or holes of various designs; fine for inaccessible installations.
- NIGRUM Impregnated Hardwood Bearings, made of selected northern hard maple and completely filled with a special lubricant; quiet, trouble-proof and efficient.



No designing or production engineer's reference files can be complete without this portfolio on "The Big Three" Lubricant-Retaining Bearings.

The whole story of Lubricant-Retaining Bearings • The Origin of Oil-Impregnated Bearings • Many methods of installation, illustrated with diagrammatical drawings • Tabulations of thousands of sizes in various types • Illustrated bulletins • Write for your copy, using your business stationery.

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BOUND BROOK OIL-LESS BEARING CO.

(Est. 1883) Main Office and Plant: BOUND BROOK, NEW JERSEY
Sales and Service: DETROIT, MICHIGAN and LOS ANGELES, CAL.

FOR BETTER MACHINES AND APPLIANCES

(b) Washers, etc.
(c) Assembling facilities.

Nordendale Mfg. Co., 2100 Fulton St., Chicago.
(a) Blanking, forming and drawing of steel, brass, aluminum, etc., on presses from 10-75 tons.
(b) To customers' specifications.
(c) Assembling and spot welding facilities.

O

O'Hara Waltham Mfg. Co., 74 Rumford Ave., Waltham, Mass.
(a) Brass, copper and steel stampings in sizes to 3 x 3 in.
(b) Dials.
(c) Porcelain enameling, spot welding, etc.

O. K. Machine Co. Inc., Fairfield and Poplar Aves., Fort Wayne, Ind.
(a) Stampings from smallest sizes to not exceeding 24 in. overall and not over 6 in. deep, of steel, brass, copper and aluminum.
(b) Laminations, cups, automatic photograph and radio, liquid dispensing pump parts, etc.
(c) Complete facilities.

P, Q

Philadelphia Steel & Wire Corp., Penn St. and Belfield Ave., Philadelphia.
(a) Punch press steel stampings, in all sizes suitable for presses up to 10 tons.
(b) To customers' specifications.
(c) Heat treating facilities.

Plymouth Stamped Metal Co., The, 330-334 Harding Way St., Galion, O.
(a) Small stampings.
(b) To customers' specifications.
(c) Complete facilities.

Powell Pressed Steel Co., Hubbard, O.
(a) All types of large or small stampings.
(b) Material handling equipment, automobile, refrigerator, washing machine parts, etc.
(c) Complete facilities.

Quadriga Mfg. Co., The, 213 W. Grand Ave., Chicago.
(a) Stampings of any material that can be worked in punch press up to 150-ton, 4 in. depth of draw.
(b) Washers, radio, automobile and any other machine parts.
(c) Complete facilities.

R

Raymond Mfg. Co., Div. Associated Spring Corp., Corry, Pa.
(a) Small stampings of steel, brass, phosphor bronze, Monel, etc.
(b) Springs, wire forms, etc.
(c) Heat treating facilities.

Reliable Spring Co., The, 3167 Fulton Rd., Cleveland.
(a) Blanking, forming, perforating, of wire, strip or plate, in steel, stainless steel, brass, phosphor bronze, etc., 1/16 in. thick x 4 in. dia.
(b) Springs, machine fittings, etc.
(c) Heat treating and assembling facilities.

Reliance Die & Stamping Co., 1260 Claybourn Ave., Chicago.
(a) Blanking, forming, perforating of brass, aluminum, bronze, steel and stainless steel.
(b) To customers' specifications.
(c) Assembling facilities.

Revere Products Corp., Phoenix, N. Y.
(a) Blanking, forming or drawing from light metals, steel, bronze, copper, stainless steel, aluminum, and brass, blanking to ¼ in. thick, forming to 36 in. long, drawing to 4 in. deep.
(b) Oil retainers, washers, escutcheons, etc.
(c) Complete facilities.

Rockford Metal Specialty Co., 716 Cedar St., Rockford, Ill.
(a) Drawing, forming, piercing of steel, stainless steel, aluminum, brass and zinc, approx. 10 in. dia. x 3½ in. cups; up to 16 in. dia. or sq. on shallow parts.
(b) Automotive and general stamping.
(c) Plating, riveting, welding, assembling and enameling.

Rockwood Sprinkler Co., 52 Harlow St., Worcester, Mass.
(a) Medium-heavy deep drawing and stamping of brass, bronze, hot and cold-rolled steel, .02-.375 in. thick, 1-12 in. blank dia.
(b) Handles, pipe unions, textile, electrical and automatic machine parts.
(c) Machining, sherardizing, parkerizing facilities.

Rome-Turney Radiator Co., Canal St., Rome, N. Y.
(a) Copper, brass and steel stampings in sizes 15 x 30 x 6 in. deep.
(b) Refrigeration air heating and cooling.
(c) Gas and spot welding, machining.

S

Scovill Mfg. Co., Waterbury, Conn.
(a) Brass, bronze, nickel silver, copper, aluminum, steel, and other metal stampings, drawn shell, formed parts and nonferrous die pressings.
(b) To customers' specifications.
(c) Complete facilities.

Service Products Corp., 201 South Rural St., Indianapolis.
(a) Blanking, forming, drawing, perforating, both heavy and light, of steel, brass aluminum, copper and bronze; draw 6 in. deep, blanking 28 x 36 in.
(b) Automotive fans, ventilators, etc.
(c) Heat treating and machining.

Shunk Mfg. Co., Bucyrus, O.
(a) Blanking, forming and perforating, all types of materials.
(b) To customers' specifications.
(c) Complete facilities.

Smith Co., Thomas, 288 Grove St., Worcester, Mass.
(a) Flat, formed, drawn or embossed, of steel, hot-rolled, cold-rolled and nonferrous metals.
(b) Diaphragms, disks, washers, cams, pawls, etc.
(c) Drilling, milling, tapping.

Standard Mfg. Corp., Rock Island, Ill.
(a) Stampings of tin, aluminum, brass, copper, light steel in any size to 8 x 12 in.
(b) Foundry chaplets and to customers' specifications.
(c) Complete facilities.

Standard Stamping Co. Inc., 530 W. Lovett St., Charlotte, Mich.
(a) Small metal stampings.
(b) Rolled bushings, split steel spacer tubes, spring clips, etc.
(c) Cyanide furnace, lathes, screw machine, etc.

Stolpher Steel Products Corp., 3258 W. Fond du Lac Ave., Milwaukee.
(a) All types of sheet metal up to quarter inch.
(b) For automotive, agricultural, and industrial fields.
(c) Complete assembling facilities, welding.

T

Textile Shield Co., 1 Groton St., Lawrence, Mass.
(a) All kinds, up to 1/16 in. thick, specializing in deep drawn work.
(b) Radio and auto parts, ferrules, etc.
(c) Annealing facilities.

Toledo Stamping & Mfg. Co., 99 Fearing Blvd., Toledo, O.
(a) Small, medium and large stampings.
(b) Automotive, tractor, washing machine and radio parts.
(c) Heat treating and assembling facilities.

Transue & Williams Steel Forging Corp., Alliance, O.
(a) Medium-sized stampings, blanked, formed, pierced and drawn, from hot and cold rolled steel, stainless steel, aluminum and Monel metal.
(b) All sizes and types of parts.
(c) Welding, brazing, punching and riveting.

Truscon Steel Co., Pressed Steel Division, 6100 Truscon Ave., Cleveland.
(a) From 20-gage to heavier gage stampings.
(b) Refrigerator, automotive, housings, washing machine, etc.
(c) None.

Turner & Seymour Mfg. Co., The, Torrington, Conn.
(a) Small stampings of steel, brass, copper, bronze, Monel, stainless steel, up to 14 in. dia., and 4 in. draw.
(b) To customers' specifications.
(c) Assembling facilities.

U

U. S. Indestructible Gasket Co., 829 E. 15th St., Brooklyn.
(a) Flat and formed, up to 8 in. round, square or irregular, x ⅛ in. thick, of steel, lead, brass, copper, bronze, aluminum, Monel, etc.
(b) Gaskets, washers, disks, rings.
(c) Machining and assembling facilities.

W

Wagner Specialty Co., P. O. Box 404, Burlington, Wis.
(a) Blanking, forming up to 10 gage material in steel, brass, copper, stainless steel, aluminum.
(b) Washers, rings, perforated plates, pump parts, handles, etc.
(c) Machining and assembling facilities.

Wall Mfg. Supply Co., P., 3126 Preble Ave., Pittsburgh.
(a) Drawn, max. blank 20 in., max. gage 16; flat in gages from 12 to 30 inclusive; of steel, brass, copper, etc.
(b) To customers' specifications.
(c) Complete facilities.

Western Cartridge Co., East Alton, Ill.
(a) Sheet metal stampings of brass, copper and copper alloys.
(b) To customers' specifications.

Whitehead Stamping Co., 1661 W. Lafayette St., Carthage, Mo.
(a) Light, medium and heavy stampings; blanks from .002 in. to ⅜ in. thick; special washers and disks blanked up to 18 in. dia.
(b) S.A.E. standard, U. S. standard, steel and brass washers.
(c) Complete facilities.

Williams, H. E., Products Co., 100-108 S. Main St., Carthage, Mo.
(a) Light stampings, steel and nonferrous metals, press size to 50 tons capacity.
(b) Automotive, electrical and miscellaneous.
(c) Turret lathes, spot welders, plating ovens for baking finishes.

Williamsport Die & Machine Co., 618 Day St., Williamsport, Pa.
(a) Medium and lightweight stampings of sheet or bar stock.
(b) To customers' specifications.
(c) Machining and some heat treating facilities.

Winchester Repeating Arms Co., Div. of Western Cartridge Co., New Haven, Conn.
(a) Brass, copper and copper alloy stampings.
(b) To customers' specifications.
(c) Machining, polishing and plating.

Worcester Pressed Steel Co., 100 Barber Ave., Worcester, Mass.
(a) Pressed metal stampings from ½ in. to 4 ft. dia., in lengths up to 7 ft., using material from .0002 to ½ in. thick, cold forgings at 1000 tons pressure.
(b) Automotive, airplane, oil burner, vacuum cleaner, transmission parts, etc.
(c) Complete facilities.

Worcester Stamped Metal Co. Inc., 9 Hunt St., Worcester, Mass.
(a) Light and heavy stampings of steel, brass, aluminum, copper and stainless steel, large and small.
(b) To customers' specifications.
(c) Annealing and hardening facilities.

Wrought Washer Mfg. Co., 2102 S. Bay St., Milwaukee.
(a) Stampings, blanking, forming, drawing, extruding, in all ferrous and nonferrous metals. Presses 300 ton capacity; material up to 1¼ in. thick.
(b) Washers, expansion plugs, automotive, etc.
(c) Complete facilities.

Y

York Corrugating Co., York, Pa.
(a) Sheet steel stampings.
(b) Automotive stampings, fenders, boiler jackets, stoker casings, gasoline pumps, etc.
(c) Assembling and welding facilities.

★

ACKNOWLEDGMENT

★

Machine Design takes this opportunity of thanking all those companies and individuals who cooperated in the compilation of the accompanying Directory of Materials, stitched into the center of this October issue. We are particularly indebted to the manufacturers of the materials for their response to requests for information on their products, and to the advertisers whose collaboration made possible the presentation.

★

This Card...

American Felt Company
S. H. FELTHOUSE
121 NO. WACKER DRIVE
CHICAGO ILL

introduces a

FELT EXPERT

THE man who sends in an American Felt Company card is worth seeing. He is not a "casual" caller. If you are a user of FELT, he will have new, late facts from the field or from the laboratory to pass on to you for the betterment of your product or the curtailment of costs. If you are not now using FELT, he will tell you how others in your industry are using FELT *profitably* . . . give you bedrock information on time or labor-saving possibilities through the use of FELT. American Felt Company representatives are salesmen . . . good salesmen . . . their aim is to counsel with you as to the *precise* FELT you need for each specific job. When you are using the *proper* FELTS, you are a satisfied FELT user. They will then take their chances of selling you *American Felts.* These men are the type of salesmen you like to do business with . . . they wear well because they serve well. Any time you want facts about FELT just drop us a line, or see the man who presents the American Felt Company card.

American Felt Company
TRADE MARK

General Offices: 315 FOURTH AVE., NEW YORK, N. Y.
Plants at Franklin, Mass., City Mills, Mass., Glenville, Conn., Newburgh, N. Y., Detroit, Mich.

PRODUCERS OF FINEST QUALITY PARTS FOR OIL RETAINERS, GREASE RETAINERS, WICKS, DUST EXCLUDERS, GASKETS, INSULATING FELTS, CHANNEL FELTS, UPHOLSTERY RISER STRIPS, BODY SILENCING PARTS, DOOR MECHANISM GASKETS, AND BODY POLISHING WHEELS

WRITE FOR DATA SHEETS

Forgings Producers

Reference letters beneath addresses of companies refer to: (a) Types, materials and sizes of forgings; (b) Names of forged machine parts customarily produced; and (c) Machining or heat treating facilities.

A

Allegheny Ludlum Steel Corp., Oliver Bldg., Pittsburgh.
(a) Disks to 24 in. dia. x 5 in. thick; rings, max. 24 in. o.d. x 20 in. i.d. x 4 in. thick; also special shapes; of high speed steels, alloy and carbon tool steels, stainless and Nitralloy.
(b) Hardened machine parts, etc.
(c) Complete facilities.

Alliance Drop Forging Co., P. O. Box 427, Alliance, O.
(a) Drop forgings.
(b) To customers' specifications.
(c) Shot-blasting, not machining or treating.

Aluminum Company of America, Gulf Bldg., Pittsburgh.
(a) Aluminum and magnesium alloy hammered and pressed forgings, in any sizes.
(b) Largely aircraft and aircraft engine parts.
(c) Heat treating facilities.
See advertisement, Page 13-D

American Brass Co., Waterbury, Conn.
(a) Hot-pressed copper, brass, bronze, nickel. silver, and special copper alloys in small sizes and shapes.
(b) To customers' specifications.
(c) None.

American Hollow Boring Co., Erie, Pa.
(a) Hollow-bored forgings.
(b) Piston rods, clutch shafts, hydraulic cylinders, etc.
(c) Complete facilities.

American Magnesium Corp., 2210 Harvard Ave., Cleveland.
(a) Hammered and pressed forgings, of magnesium alloys, in any size.
(b) To customers' specifications.
(c) Heat treating facilities.
See advertisement, Page 4-D

Atlas Drop Forge Co., 209 W. Mount Hope Ave., Lansing, Mich.
(a) All sizes and shapes, any material, from few ounces to 500 lbs.
(b) Farm implements, tractors, railroad, aviation, automotive, etc.
(c) Complete heat treating facilities.

Atwater Mfg. Co., Plantsville, Conn.
(a) Drop and upset forgings of steel up to 20 lbs.
(b) To customers' specifications.
(c) Heat treatment.

B

Benton Harbor Malleable Industries, Benton Harbor, Mich.
(a) Drop hammer steel forgings to 80 pounds.
(b) All types of parts.
(c) Heat treating facilities.

Bethlehem Steel Co., Bethlehem, Pa.
(a) Open die forgings to 225,000 lbs. in all grades of carbon and alloy steels—solid and hollow. Drop forgings from 1 lb. to 350 lbs. Also upset forgings.
(b) Shafts, rotors, rolls, gears and other press and hammer forgings.
(c) Complete facilities.

Billings & Spencer Co., The, 1 Laurel St., Hartford, Conn.
(a) All types in brass, bronze, stainless steel, alloys, straight carbon steel, Monel metal and tool steel; to 100 lbs.
(b) Airplane, automobile, machine tool parts, gas and diesel engine, conveyor, mining machinery, typewriter parts, etc.
(c) Complete facilities.

Blakeslee Forging Co., The, Plantsville, Conn.
(a) Light drop forgings to 25 lbs., all grades steel, brass, bronze and copper.
(b) To customers' specifications.
(c) Machining, normalizing and annealing.

Bonney Forge & Tool Works, Allentown, Pa.
(a) Drop forging from 1 ounce to 8 lbs. of any grade steel, alloy or carbon; also small upset forgings.
(b) Machine handles, etc.
(c) Complete facilities.

Brewer-Titchener Corp., 111 Port Watson St., Cortland, N. Y.
(a) Hammer forgings 1000-4000 lbs.; upset forgings ¾-4 in.; and any forgings within the range of 1 ounce to 15 lbs.
(b) Automotive parts.
(c) Complete facilities.

Brown-Fayro Co., The, 940 Ash St., Johnstown, Pa.
(a) Hammered, upset, pressed, rolled, and welded, small and medium.
(b) Mine, industrial and railroad cars, etc.
(c) Machining facilities.

Buckeye Forging Co., 10001 Harvard Ave., Cleveland.
(a) Small forgings of carbon and alloy steels, stainless steels, brass and copper.
(b) Automotive, tractor, tank, etc.
(c) Machining facilities.

C

Cape Ann Tool Co., 146 Granite St., Pigeon Cove, Mass.
(a) All types and sizes of drop and upset forgings in ferrous and nonferrous metals.
(b) To customers' specifications.
(c) Heat treating facilities.

Carnegie-Illinois Steel Corp., 434 Fifth Ave., Pittsburgh.
(a) All type forgings produced with open dies, in all types of steel. Round—body diameter 68 in., max. collar diameter, 90 in., max. weight 220,000 lbs. Rectangular—up to 30 in. max. thickness, 150 in. max. width, with max. weight of 220,000 lbs. Hollow rounds —max. outside diameter 140 in.
(b) Marine, axles, bars, bridge pins, crankshafts, hexagon shafts, propeller shafts, rotors, locomotive, back up rolls, sleeves, pinions, reduction gears, spindles, mill housings, etc.
(c) Complete facilities.

Carpenter Steel Co., The, 120 Bern St., Reading, Pa.
(a) Simple forgings made on flat dies in all S.A.E., stainless and tool steels up to 3000 lbs.
(b) Rings, disks, blocks, simple shafts, axles, etc.
(c) All heat treating facilities; minimum of machine work.

Champion Machine & Forging Co., 3695 E. 78 St., Cleveland.
(a) All type steel forgings to 800 lbs.
(b) To customers' specifications.
(c) Complete facilities.

Chase Brass & Copper Co. Inc., 236 Grand St., Waterbury, Conn.
(a) Brass, naval brass, copper and copper alloy, and Olympic bronze.
(b) Automotive, aircraft, refrigeration parts, air valves, etc.
(c) Annealing, machining, polishing and plating facilities.

Clapp, E. D., Mfg. Co., 305 Genesee St., Auburn, N. J.
(a) Drop forgings of stainless steel, Monel, brass, bronze, copper, etc.
(b) Aircraft, automotive, railroad, tractor, etc.
(c) Complete facilities.

Cleveland City Forge Co., 4501 Lakeside Ave., Cleveland.
(a) Drop and upset forgings of carbon and alloy steel, from few ounces to several hundred pounds.
(b) To customers' specifications.
(c) Complete facilities.

Cleveland Hardware & Forging Co., 3270 E. 79th St., Cleveland.
(a) Drop and upset forgings in steel and brass.
(b) To customers' specifications.
(c) Complete facilities.

Clifford-Jacobs Forging Co., Box 264, Champaign, Ill.
(a) Drop forgings.
(b) Steel flanges, center plates, wedges, hubs, gears, conn. rods.
(c) Information not available.

Cornell Forge Co., 1659 W. 74th St., Chicago.
(a) All type drop forgings, from fraction of an ounce to 15 lbs.; carbon steel, alloy, Monel, stainless steel, and aluminum.
(b) Cams, crankshafts, pins, gears, hubs, valves, connecting rods, etc.
(c) Heat treating, annealing, sandblasting and some machining.

Crucible Steel Co. of America, 405 Lexington Ave., New York.
(a) All types of forgings in carbon and alloy grades, to 40 tons max. weight.
(b) Crankshafts, propeller shafts, piston rods, rams, gun forgings, etc.
(c) Complete facilities.

D

Davenport Besler Corp., 2305 Rockingham Rd., Davenport, Ia.
(a) Drop forgings and open steam hammer forgings.
(b) Crankshafts, connecting rods, levers, automotive and railway equipment.
(c) Complete facilities.

Delaware Alloy Forge Co., 2300 E. Tioga St., Philadelphia.
(a) Flat die steam hammer work in stainless steel, tool steel, Nitralloy, Monel metal, bronze and other alloys from 1-5000 lbs.
(b) Seat rings for large valves, knitting machine cylinders, paper machinery shafts, and gears.
(c) Complete facilities.

Dow Chemical Co., The, Midland, Mich.
(a) Magnesium alloy forgings.
(b) To customers' specifications.
(c) Heat treating facilities.
See advertisement, Page 15-D

Drop Dies & Forgings Co., 3097 E. 61st St., Cleveland.
(a) Drop forgings up to 25 lbs.
(b) To customers' specifications.
(c) None.

E

Ellwood City Forge Co., Box 589, Ellwood City, Pa.
(a) Steel forgings from 25 to 35,000 lbs.
(b) Crankshafts, aircraft, automobile, gas,

MOLYBDENUM IN STEEL
MOLYBDENUM IN IRON

TWO VALUABLE BOOKS–

For Your Metallurgical Library

"MOLYBDENUM IN STEEL" *and* **"MOLYBDENUM IN CAST IRON"**

More than ever before improved materials are imperative to meet increasing costs and competition and severe service conditions. Molybdenum steels and irons, Industry's modern materials, continue to prove themselves the answer to many ferrous problems.

The most recent, thorough and authoritative data on Molybdenum in steel and iron will be found in two books compiled and published by the Climax Molybdenum Company: "Molybdenum In Steel" and "Molybdenum In Cast Iron".

Either or both of these important technical books will be sent on request to any company or individual actively interested in the metallurgy and application of ferrous materials. There is neither charge nor obligation involved.

Additional information on Molybdenum steels and irons will gladly be supplied those with special problems on receipt of sufficiently detailed information with regard to the requirements to be met. It will pay you to re-study your material specifications.

MOLY

Climax Mo-lyb-den-um Company
500 Fifth Avenue · New York City

steam, or diesel engines.
(c) Complete facilities.

Endicott Forging & Mfg. Co. Inc., Endicott, N. Y.
(a) Drop and upset forgings, of carbon and alloy steels, Monel, stainless, Nitralloy, brass, copper and bronze, from 2 ozs. to 80 lbs.
(b) Gear blanks, crankshafts, connecting rods, rocker arms, etc.
(c) Heat treating facilities.

F

Federal Drop Forge Co., 2200 S. Washington Ave., Lansing, Mich.
(a) Drop forgings up to 25 lbs.
(b) To customers' specifications.
(c) Information not available.

Finkl, A., & Sons Co., 2011 N. Southport Ave., Chicago.
(a) Hammer and press forgings in carbon and alloy steels from 5-50,000 lbs.
(b) Shafts, rolls, rings, gear and pinion blanks, etc.
(c) Complete facilities.

Forging & Casting Corp., The, 1350 Jarvis Ave., Ferndale, Mich.
(a) Smooth hammered forgings, of S.A.E. grades of steel, from ½ lb.-1500 lbs.
(b) Rings, blocks, disks, and irregular shapes.
(c) Annealing facilities.

Forgings & Stampings Inc., 23rd Ave. and Seventh St., Rockford, Ill.
(a) Drop forgings.
(b) To customers' specifications.
(c) Information not available.

G

General Drop Forge Co. Inc., 1738 Elmwood Ave., Buffalo.
(a) Hammered and upset forgings, of carbon, stainless, Monel, brass, copper and alloys, 1 oz.-100 lbs.
(b) Rings, gears, stem pinions, side gears, connecting rods, etc.
(c) Heat treating facilities.

Globe Forge & Foundries Inc., Peat Street, Syracuse, N. Y.
(a) Drop and upset forgings in carbon and alloys from few ounces to 125 lbs.
(b) Differential, transmission gears.
(c) Complete facilities.

Great Lakes Forge Co., 612 N. Michigan Ave., Chicago.
(a) Drop and upset forgings, of alloy and carbon steel, to 100 lbs.
(b) To customers' specifications.
(c) Complete heat treating facilities.

H, I

Hammond & Irving Inc., 254 North St., Auburn, N. Y.
(a) Steam hammer forgings in alloy and tool steels, stainless, Nitralloy and Monel metals, up to 1200 lbs.
(b) Weldless rings, gear blanks, shafts, hammered bars, etc.
(c) Complete facilities.

Harris-Thomas Drop Forge Co., 126 Harshman St., Dayton, O.
(a) Drop forgings.
(b) To customers' specifications.
(c) Information not available.

Harrisburg Steel Corp., 10th and Herr Sts., Harrisburg, Pa.
(a) Alloy and carbon open hearth steel drop forgings which can be produced on steam drop hammers from 2000 to 8000 lbs.
(b) All types of machine parts.
(c) Complete facilities.

Hartford Drop Forge Div., Cokewell Mfg. Co., 846 Windsor St., Hartford, Conn.
(a) Die and drop forgings in steel, copper, brass, Monel, up to 7 lbs.
(b) Gears, levers, loom parts, and any part to customers' specifications.
(c) None.

Heppenstall Co., 4622 Hatfield St., Pittsburgh.
(a) Forgings of carbon, alloys, and steels, up to 45,000 lbs. rough turned weight.
(b) Shafts, crankshafts, die blocks, shear knives, rolls, etc.
(c) Complete facilities.

Herbrand Corp., Fremont, O.
(a) Drop forgings.
(b) Automobile, etc.
(c) Heat treating facilities.

International Nickel Co. Inc., 67 Wall St., New York.
(a) Monel, K Monel, nickel, and Inconel—max. slabs 20 x 30 x 10,000 lbs. or 25 in. dia. x 11,000 lbs.
(b) Miscellaneous parts.
(c) Complete facilities.
See advertisement Page 53-D

Interstate Drop Forge Co., 4041 N. 27th St., Milwaukee.
(a) Drop and upset forgings of carbon, alloy and stainless steel.
(b) Levers, gears, segments, hydraulic fittings, connecting rods, crankshafts, etc.
(c) Heat treating facilities.

J

Jersey Forging Works, 803 Jersey Ave., Jersey City, N. J.
(a) Alloy steel and Standard S.A.E. steel forgings.
(b) Gear blanks, rings, sleeves, rolls, shafts, spindles, etc.
(c) Complete facilities.

Johnston & Jennings Co., 872 Addison Rd., Cleveland.
(a) Flat die forgings in plain carbon and alloy steels, 1 to 5 tons.
(b) Spindles, solid and hollow-bored, rings, blanks, arbors, shafts, gears, etc.
(c) Complete machine shop facilities.

Jones & Laughlin Steel Corp., Third and Ross St., Pittsburgh.
(a) Smooth, rough turned and finished forgings of any size.
(b) To customers' specifications.
(c) Annealing, normalizing and heat treating.

K

Kortick Mfg. Co., 345 First St., San Francisco.
(a) Drop forgings.
(b) Bolts, nuts, washers, etc.
(c) Information not available.

Kraeuter & Co. Inc., 585 Eighteenth Ave., Newark, N. J. (Drop Forging Div., Nye Ave. and S. Twentieth St., Irvington, N. J.)
(a) Closed die and upset forgings, of carbon, Monel, stainless steel, bronze and alloy steels, ½ oz. to 20 lbs.
(b) To customers' specifications.
(c) Limited facilities.

Kropp Forge Co., 5301 W. Roosevelt Rd., Chicago.
(a) Steam hammer to 20 tons; drop and upset.
(b) To customers' specifications; merchant bars, die blocks, flanges.
(c) Machining, heat treating, Magnaflux inspection.
See advertisement Page 73-D

L

Lakeview Forge & Clevis Co., Pittsburgh Ave., Erie, Pa.
(a) Drop forgings up to 10 lbs. in alloy or carbon steel.
(b) To customers' specifications.
(c) Heat treating facilities.

Lamson & Sessions Co., The, Cleveland, Chicago and Birmingham, Ala.
(a) Small hot and cold forgings of any metal or alloy.
(b) Bolts, nuts, cotters, cap screws and special hot and cold upset products.
(c) Complete facilities.

Lansdowne Steel & Iron Co., Morton, Pa.
(a) Hollow forgings.
(b) To customers' specifications.
(c) Complete facilities.

Lansing Drop Forge Co., Logan and Albert Sts., Lansing, Mich.
(a) Drop forgings to 80 lbs., upset forgings, coined and machined forgings, of all grades of carbon, Monel metal, aluminum and other alloys, from 2 ozs. to about 80 lbs.
(b) Steering arms, shift levers, small crankshafts, camshafts, shock absorber arms, rocker arms, gears, housings, etc.
(c) Complete facilities.

Latrobe Electric Steel Co., Latrobe, Pa.
(a) High speed steel and stainless steel forgings, blocks approx. 16 in. cube, flats approx. 20 x 10.
(b) Shear blades, disks, etc.
(c) Heat treating facilities.

Leard, William, Co. Inc., New Brighton, Pa.
(a) Hammered and hydraulic pressed steel forgings up to 25,000 lbs.
(b) Crankshafts, connecting rods and other type forged steel shafts.
(c) Complete facilities.

Lindell Drop Forge Co., S. Logan and N. Y. C. R. R., Lansing, Mich.
(a) Carbon and alloy steel forgings, from 1 oz. to 75 lbs.
(b) For automotive, agricultural, mining machinery, etc.
(c) Limited machining.

M

Machinery Forging Co., The, 5450 Hamilton Ave., Cleveland.
(a) Flat die forgings of carbon and alloy steels, 1 to 2000 lbs.
(b) Rings, disks, blocks, spindles, bars, hubs, etc.
(c) Rough turning only.

Melling Forging Co., 1401 Case St., Lansing, Mich.
(a) Steel drop forgings; from 1 oz. to 8 lbs.
(b) To customers' specifications.
(c) Complete facilities.

Merrill Brothers, 56 Arnold Ave., Maspeth, Queens, N. Y.
(a) Drop forgings of steel and alloys, from fraction of oz. to 100 lbs. or more.
(b) Turnbuckles, clevis nuts, shackles, eyebolts, hexagon sleeve nuts, etc.
(c) Complete facilities.

Mesta Machine Co., Box 1466, Pittsburgh.
(a) Very large steel and alloy steel forgings.
(b) Shafts, pinions, rolls, etc.
(c) Complete facilities.

Midvale Co., The, Nicetown, Philadelphia.
(a) Press or hammer forgings, solid or hollow, in carbon or alloy steel.
(b) All types of parts.
(c) Complete facilities.

Mitchell Steel Co., The, Stockyards Station, Cincinnati.
(a) Steam hammer forgings in plain carbon, alloy and stainless steel.
(b) All types of machine parts, railroad, marine, etc.
(c) Complete facilities.

Modern Die & Drop Forge Co., 2600 W. 139th St., Blue Island, Ill.
(a) Drop forgings.
(b) To customers' specifications.
(c) Information not available.

Mondie Forge Co. Inc., 10300 Berea Rd., Cleveland.
(a) Drop forgings up to 75 lbs., upset forgings to 4 in., also gear blanks.
(b) To customers' specifications.
(c) Machining facilities.

Moore Drop Forging Co., 36 Walter St., Springfield, Mass.
(a) Drop, upset and coined forgings.
(b) To customers' specifications.
(c) Heat treating and machining.

N

National Forge & Ordnance Co., Irvine, Warren Co., Pa.
(a) Flat die press and hammered steel forgings.
(b) Heavy-duty crankshafts, etc.
(c) Complete facilities.

National Lock Washer Co., 40 Hermon St., Newark, N. J.
(a) Small drop forgings.
(b) Various custom forgings to order.
(c) Heat treating and machining.

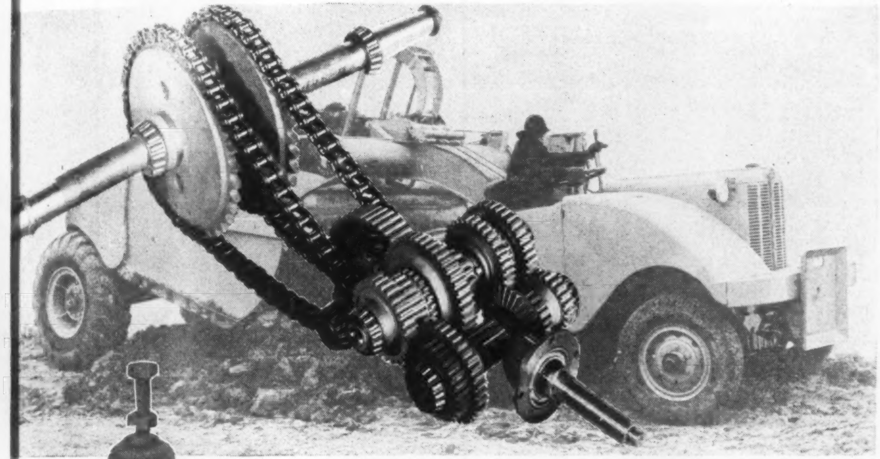
O

Octigan Forge Co., 2824 S. Lowe Ave., Chicago.
(a) Drop forgings.
(b) To customers' specifications.
(c) None.

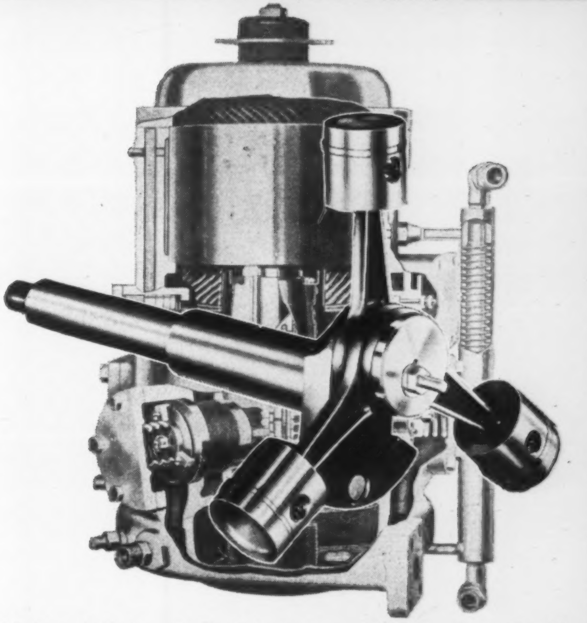
Ohio Forge & Machine Corp., 3010 Woodhill Rd., Cleveland.
(a) Drop, upset and flat hammer steel forgings in all sizes.

The specific combination of "QUALITY ADVANTAGES" required for any part

IS OBTAINABLE IN *Forgings*



The gears in this Koehring High Speed Tractor Transmission are forgings in which the grain structure and fiber formation of the metal has attained its maximum refinement and toughness, thereby providing plus strength and endurance.



This forged steel, perfectly balanced, crankshaft insures the trouble-free operation of Chrysler Airtemp Air-Conditioning Units. The secret of Airtemp compactness is in this radically new and extremely efficient radial compressor of which this forged steel crankshaft is the principal operating part, and must possess high fatigue resistance.

This cut-away view of "Servo" Mechanical Governor, manufactured by the King Seeley Corporation, shows operating fork, weight carrier, weights and lever, all of which are forgings. These parts must possess an exact degree of hardness and toughness which is obtainable in forgings, after heat treatment, in the exact degree desired.

CHECK the "quality advantages" required for each part with those offered by forgings. There are no compromises with quality necessary in using forgings. Because of plus strength in lighter sectional thicknesses, you can safely achieve a reduction of deadweight, and this advantage may be combined with such other "quality advantages" as uniformity of physical properties, low machining costs, welding adaptability. Any one of several "quality advantages" of forgings may become the primary consideration for using forgings, in which case you will get a secondary group of "quality advantages" because they are inseparable from the primary advantage. "Quality advantages" which are not otherwise available are usually obtainable in forgings.

In forgings, plus tensile and torsional strength is obtained through controlled grain flow and distribution of metal, rather than by metal bulk. Forging kneads metal into a dense mass of flawless strength—strength that is achieved through a concentration of grain structure and fiber formation at points of greatest shock or strain, thereby providing high fatigue resistance and assuring dependable performance over longer periods of use. Forgings are formed to close tolerances in dies that assure uniform size and shape, thereby reducing machining cost because there is no bulk of excess metal to remove, while unusual freedom from concealed defects avoids loss from rejections. Consult a competent forging engineer about the various combinations of "quality advantages" that are obtainable in forgings.

DROP FORGING TOPICS

"Drop Forging Topics" presents actual applications of forgings in a wide variety of types of equipment and tells the advantages and economies derived from the use of forgings by various manufacturers. "Drop Forging Topics" is sent to engineers, designers, metallurgists, production and management executives. If you are not receiving it, send us your name today. It's free.

7 "QUALITY ADVANTAGES" OF FORGINGS:

1. **Strength:** plus tensile and torsional strength.
2. **Uniformity of Physical Properties:** obtainable in forgings in the exact degree desired.
3. **Weight Reduction:** through plus strength and lighter sectional thicknesses.
4. **Welding Adaptability:** widest range for fabricating complicated parts from two or more forgings.
5. **Lower Machining Costs:** forgings shaped in closed dies require a minimum of machining and finishing.
6. **Safety:** through freedom from concealed defects.
7. **Endurance:** forgings provide high fatigue resistance which insures dependable performance over longer periods of use.

THERE ARE NO SUBSTITUTES FOR FORGINGS

DROP FORGING ASSOCIATION

605 HANNA BUILDING · CLEVELAND, OHIO

SYMBOLIC EMBLEM OF THE DROP FORGING ASSOCIATION

(b) Gear blanks and other machine parts.
(c) Complete heat treating, machining for gears and shafts only.

O'Leary & Son Co., Arthur J., 5757 West 65th St., Chicago.
(a) Upset and steam hammered forgings of medium and mild steels and alloys, to 5 in. dia. upsetting and to 10 in. dia. steam hammer.
(b) Eye bolts, special bolts, upset bolts, fabricated steel parts, upset links, etc., and to customers' specifications.
(c) Complete facilities.

Oliver Iron & Steel Corp., N. E. Corner S. 10th and Muriel Sts., Pittsburgh.
(a) Small forgings in iron, steel and alloys in sizes of 8 in., and weight of 5 lbs. Large and small upset bars.
(b) Bolts, nuts, rivets, hot or cold headed special parts of all kinds.
(c) Complete facilities.

Owensboro Forging Co., Owensboro, Ky.
(a) Drop forgings.
(b) To customers' specifications.
(c) Heat treating facilities.

P

Park Drop Forge Co., The, 730 E. 79th St., Cleveland.
(a) All types of drop steel forgings up to 4000 lbs. each.
(b) Crankshafts, connecting rods, camshafts, axles, gears, etc.
(c) Complete machining, heat treating.

Pittsburgh Forgings Co., Coraopolis, Pa.
(a) Drop and upset forgings, from 1 oz. to 350 lbs.
(b) Automotive, tractor, farm implement, railroad car, machine tool parts, and gear blanks.
(c) Complete heat treating.

Pittsburgh Forgings Co., Riverside Div., Jackson, Mich.
(a) Drop forgings, from 3 lbs. to 50 lbs.
(b) Specialty, automotive hubs and tractor wheels.
(c) Complete facilities.

Pittsburgh Trolley & Forge Co., 117 Water St., Pittsburgh.
(a) Forgings in carbon and alloy steels, up to 2000 lbs.
(b) Spindles, shafts, gears, rings, etc.
(c) Complete facilities.

Poor & Co., Canton Forge & Axle Works, 2027 Dueber Ave., S. W., Canton, O.
(a) Drop die and upset forgings in carbon and alloy steels, from 1 to 350 lbs.
(b) Spindles, levers, gears, etc.
(c) Heat treating facilities.

Porter Forge & Furnace Inc., 6 Ashland St., Everett, Mass.
(a) Drop forgings of standard and special steels and metals.
(b) To customers' specifications.
(c) Complete heat treating facilities.

Portland Forge & Fdry. Co., Portland, Ind.
(a) Board hammer, upset forgings of steel bars, up to 60 lbs.
(b) Gears, etc.
(c) Complete facilities.

R

Revere Copper & Brass Inc., (Dallas Div.) 2200 N. Natchez Ave., Chicago.
(a) Die pressed and hammered forgings, of nonferrous alloys, from fraction of ounce to 19 lbs.
(b) To customers' specifications.
(c) Complete facilities.

Rhode Island Tool Co., 148 W. River St., Providence, R. I.
(a) Drop forgings of carbon, alloy and stainless steels, 10 in. dia., 1½ in. thick; 2 in. dia., 18 in. long.
(b) Grippers, wrenches, eyebolts, gear blanks, etc.
(c) Heat treating facilities.

Rockford Drop Forge Co., 1033 Ninth St., Rockford, Ill.
(a) Drop forgings.
(b) Automotive and industrial clutches, etc.
(c) Information not available.

Rome Mfg. Co. Div., Revere Copper & Brass Inc., Railroad St., Rome, N. Y.
(a) Hot pressed forgings in brass, copper and related alloys.
(b) To customers' specifications.
(c) Complete facilities.

S

St. Pierre Chain Corp., 50 Frank St., Worcester, Mass.
(a) All types of forgings of alloys, soft steels, etc., from 1 oz. to 50 lbs.
(b) Automobile, airplane and other machine parts.
(c) Complete facilities.

Scovill Mfg. Co., Waterbury, Conn.
(a) Made-to-order forgings from brass, bronze, copper, and aluminum in all sizes.
(b) To customers' specifications.
(c) Complete facilities.

Shuler Axle Co. Inc., 2901 S. Second St., Louisville, Ky.
(a) All type forgings in carbon and alloy steel, from 1 to 300 lbs.
(b) Automotive and trailer axles, also heavy-duty two-shoe brakes.
(c) Complete facilities.

Spencer Mfg. Co., Spencer, O.
(a) Rolled, hammered and upset forgings, in practically any size.
(b) Axle forgings.
(c) Heat treating facilities.

Spicer Mfg. Corp., Toledo, O.
(a) Drop, upset and pressure forgings in plain and alloy steels, up to 30 lbs.
(b) Universal joint yokes, forks, gears, shafts, etc.
(c) Complete facilities.

Steel Improvement & Forge Co., 960 Addison Rd., Cleveland.
(a) Drop hammer, upset and press forging.
(b) Machine tool, aircraft, automotive, truck and tractor, marine and coal industries.
(c) Complete facilities.

Storms Drop Forging Co., P. O. Box 1688, Springfield, Mass.
(a) Drop forgings, from fraction of ounce to 50 lbs., in all grades of forgeable materials; also hot pressed brass forgings.
(b) To customers' specifications.
(c) Complete heat treating.

T

Taylor Forge & Pipe Works, P. O. Box 485, Chicago.
(a) Drop, upset and hammer forgings of carbon and alloy steels, some nonferrous metals, up to 114 in. o.d.
(b) Flanges, rings, nozzles, necks, gear blanks, etc.
(c) Complete facilities.

Taylor-Wharton Iron & Steel Co., (Easton, Pa. plant), High Bridge, N. J.
(a) Upset forgings made on 2 in. to 5 in. upsetting machines.
(b) To customers' specifications.
(c) Complete facilities.

Transue & Williams Steel Forging Corp., Alliance, O.
(a) All sizes and types of drop forgings from 1 oz. to 1000 lbs. of carbon steels, alloys and nonferrous metals.
(b) Various sizes and types of connecting rods, crankshafts, camshafts, bearing caps, driveshafts and gears.
(c) Complete heat treating.

U

Union Forging Co., Endicott, N. Y.
(a) Drop and press forgings.
(b) Automotive parts.
(c) Heat treating facilities.

V

Vulcan Steam Forging Co., 223-257 Rano St., Buffalo, N. Y.
(a) Open die forgings of carbon, alloy, tool and stainless steels, and nonferrous metals.
(b) Gear blanks, crankshafts, piston rods, levers, spindles, rolls, weldless rings, shaped work.
(c) Complete facilities.

W

Wilcox Mfg. Co., The D., N. Chestnut and E. Allen Sts., Mechanicsburg, Pa.
(a) Drop forgings of alloy and carbon steel, 1 oz. to 30 lbs.
(b) To customers' specifications.
(c) Heat treating facilities.

Williams, J. H., & Co., 400 Vulcan St., Buffalo, N. Y.
(a) Drop forgings in steel and nonferrous metal from ½ oz. to 100 lbs.
(b) Structural forged parts, gears, levers, cams, cranks, etc., for machine tools, gas engines, compressors, aircraft, automotive, etc.
(c) Complete facilities.

Wyman-Gordon Co., Worcester, Mass., and Harvey, Ill.
(a) Drop hammer, upset and press forgings in steel and aluminum from 10 to 500 lbs.
(b) Automotive and aviation.
(c) Heat treating facilities.

THIS CAN BE FILED FOR REFERENCE!

★

These pages represent the eighth edition of the Directory of Materials. Presented as an integral part of the October, 1940, issue of MACHINE DESIGN, it is written and compiled for design executives in the machinery manufacturing field with the express purpose of bringing together factual information that will aid them in their daily problems.

To serve readers most effectively the Directory has been stitched separately as a composite unit, and then stapled into the center of the magazine so that it can be taken out by removing two staples without injury to the insert or to the magazine proper. This permits filing by subject to provide ready reference.

With the editorial contents compiled and edited to assist designers of machinery in selecting the best possible material to meet their requirements, the Supplement will find immediate acceptance and use. The editorial pages as well as the advertising section constitute a veritable "Where-To-Buy" Directory.

Like MACHINE DESIGN's previously-published "Machine Drives and Controls" Supplement and other special features covering specific phases of design, this new edition of the Directory of Materials adds another valuable reference work to the engineer's library.

MACHINE DESIGN

The Professional Journal of
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Covers every size and type of machinery---from the "Wristwatch to the Locomotive"

Meet your Production
Requirements with
ABSCO MEEHANITE
Castings in Quantity Lots

Cooling plates, ground and polished on upper surface made of Meehanite by American Brake Shoe and Foundry Co.

You can rely on castings of ABSCO Meehanite in quantity lots for the uniformity needed to meet today's exacting production schedules and contract requirements.

6 Controlled Qualities of ABSCO MEEHANITE

1. ***Combined strength and toughness***
2. ***Acid and corrosion resistance***
3. ***Abrasion and erosion resistance***
4. ***Pressure tightness***
5. ***Ability to stand shock and strain***
6. ***Intense hardness through chilling or heat treatment***

For full particulars write to Department D

**THE AMERICAN BRAKE SHOE
AND FOUNDRY COMPANY**

BRAKE SHOE AND CASTINGS DIVISION

FOUNDRY
MAHWAH
NEW JERSEY

OFFICES
230 Park Avenue, New York, N. Y.
332 South Michigan Ave., Chicago, Ill.

Die Castings Producers

Reference letters beneath addresses of companies refer to: (a) Types, materials and sizes of die castings; (b) Names of die-cast parts customarily produced; and (c) Machining, finishing and assembling facilities.

A

Advance Pressure Castings Inc., 34 N. 15th Ave., Brooklyn.
(a) Aluminum and zinc alloy die castings, to 5 and 12 lbs. respectively.
(b) To customers' specifications.
(c) Complete facilities.

Aluminum Co. of America, Die Casting Div., Garwood, N. J.
(a) Aluminum die castings to 20 lbs., zinc to 45 lbs., and magnesium die castings.
(b) To customers' specifications.
(c) Machining, finishing facilities.
See advertisement, Page 13-D

American Magnesium Corp., 2210 Harvard Ave., Cleveland.
(a) Low and high pressure die castings of various magnesium alloys, in any size.
(b) To customers' specifications.
(c) Light machining.
See advertisement, Page 4-D

Aurora Metal Co., 614 W. Park Ave., Aurora, Ill.
(a) Aluminum bronze and silicon bronze die castings.
(b) Variety of machine parts.
(c) Complete facilities.

C

Cincinnati Die Casting Co., 2121 Spring Grove Ave., Cincinnati.
(a) From small to very large zinc base, high-tensile aluminum and magnesium alloy die castings.
(b) Automotive, radio, mechanical, etc.
(c) Complete facilities.

Cleveland Hardware & Forging Co., 4518 Lakeside Ave., Cleveland.
(a) Aluminum and zinc from minute to 12½ lbs.
(b) Automotive, musical machines, vacuum cleaners, sewing machines, motors and domestic appliances.
(c) Complete facilities.

Congress Die Casting Div., 3750 E. Outer Drive, Detroit.
(a) Zinc alloy die castings, to 10 lbs.
(b) Pulleys, flexible couplings, vending machine, washing machine, radio, woodworking machine and automotive parts.
(c) Complete facilities.

D

Dayton Die Casting Co., 303 Keowee St., Dayton, O.
(a) Zinc alloy, lead and tin die castings.
(b) To customers' specifications.
(c) Complete facilities.

Doehler Die Casting Co., Toledo, O. (Other plants at Batavia, N. Y., and Pottstown, Pa.)
(a) Zinc, aluminum, brass, bronze, tin, lead and magnesium die castings.
(b) All types of machine parts.
(c) Machining and finishing facilities.

Dollin Corp., 610 S. 21st St., Irvington, N. J.
(a) All sizes, in aluminum, zinc and magnesium alloys.
(b) Variety of machine parts.
(c) Machining and finishing facilities.

Dow Chemical Co., Midland, Mich.
(a) Dowmetal and magnesium alloy die castings.
(b) All types of automotive, aircraft and other machine parts.
(c) None.
See advertisement, Page 15-D

F

Federal-Mogul Corp., 11031 Shoemaker Ave., Detroit.
(a) Tin and lead base, medium and small die castings.
(b) Primarily bearings and bushings.
(c) Complete facilities.

H

Hoover Co., The, Maple and McKinley Sts., North Canton, O.
(a) Aluminum and zinc die castings, to 24 in. square.
(b) To customers' specifications.
(c) Complete facilities.

L

Latrobe Die Casting Co., Latrobe, Pa.
(a) Aluminum, zinc, tin and lead alloy die castings.
(b) Automotive, radio, office, household appliances, etc.
(c) Complete facilities.

Los Angeles Die Casting Co., 340 Crocker St., Los Angeles.
(a) Zinc base, yellow brass and aluminum die castings from ½ oz. to 15 lbs.
(b) To customers' specifications.
(c) Complete facilities.

M

Madison-Kipp Corp., 201 Waubesa St., Madison, Wis.
(a) Zinc, aluminum, magnesium, and brass die castings, all sizes.
(b) Automotive, household appliance, railway, etc.
(c) Complete facilities.
See advertisement, Page 16-D

McGill Mfg. Co., Metal Div., Valparaiso, Ind.
(a) Aluminum, bronze and special hard bronze die castings, from ½ oz. to 10 lbs. Hydraulic pressure castings of hard yellow brass and silicon bronze, ½ oz. to 2 lbs.
(b) Great variety of machine parts including gears, levers, and other corrosion resistant machine parts.
(c) Complete facilities.

Milwaukee Die Casting Co., 1015 N. Fourth St., Milwaukee.
(a) Zinc to 5 lbs.; lead, tin to 14 lbs.
(b) Motor cases, electrical apparatus, business machine, washing machine, etc.
(c) Machining and finishing facilities.

N

National Lock Co., 1902 Seventh St., Rockford, Ill.
(a) Zinc die castings to 12 in.
(b) To customers' specifications.
(c) Complete facilities.

Newton-New Haven Co., 683 Third Ave., West Haven, Conn.
(a) Zinc base and high pressure aluminum die castings to 3 lbs.
(b) Aviation parts.
(c) Finishing facilities only.

P

Paragon Die Casting Co., 5851 W. Dickens Ave., Chicago.
(a) Zinc and aluminum die castings.
(b) Auto, radio, refrigerator, food mixer. washing machine, etc.
(c) Machining and plating facilities.

Parker White Metal & Machine Co., McKinley Ave., at 23rd St., Erie, Pa.
(a) Zinc base die castings in any size.
(b) All types of machine parts.
(c) Complete facilities.

Precision Castings Co. Inc., Fayetteville, N. Y. (Branch, Cleveland, O.; Die Shop, Syracuse, N. Y.)
(a) Aluminum and zinc castings from fraction of ounce to 26 lbs.
(b) Automotive, household appliances, outboard motors, etc.
(c) Machining, assembling facilities.

Precision Castings Co. Inc., Syracuse, N. Y. (also Cleveland).
(a) Zinc and aluminum die castings, large or small.
(b) To customers' specifications.
(c) Machining and finishing facilities.

Pressure Castings Inc., 21500 St. Clair Ave., Cleveland.
(a) Zinc and aluminum alloy die castings to 24 x 24 in.
(b) To customers' specifications.
(c) Finishing and machining facilities.

S

Schultz Die Casting Co., 1810 Clinton St., Toledo, O.
(a) Zinc base die castings.
(b) Automotive, etc.
(c) Machining and finishing facilities.

Stewart Die Casting Div., Stewart-Warner Corp., 4535 Fullerton Ave., Chicago.
(a) Zinc and aluminum castings to 20 lbs.
(b) To customers' specifications.
(c) Finishing facilities.

Superior Die Casting Co., 17325 Euclid Ave., Cleveland.
(a) Zinc and aluminum alloy die castings.
(b) Various machine parts.
(c) Information not available.

T

Titan Metal Mfg. Co., Bellefonte, Pa.
(a) Brass and bronze; up to 2 lbs.
(b) Electrical, refrigeration, and miscellaneous parts up to 20 lbs.
(c) Machining and assembling.

Toman, E., & Co., 2621 W. 21st place, Chicago.
(a) All types of zinc base die castings from ½ oz. to 4 lbs.
(b) To customers' specifications.
(c) Complete facilities.

U

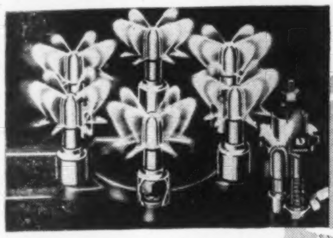
Union Die Casting Co. Ltd., 2313 E. 51st St., Los Angeles.
(a) All kinds of zinc alloy die castings.
(b) Automotive, lubricating equipment, etc.
(c) Complete facilities.

Universal Bearing Co., 639 Broadway, Lorain, O.
(a) Universal bearing metal die castings.
(b) Bearings.
(c) Information not available.

V

Veeder-Root Inc., Hartford, Conn.
(a) Precision die castings.
(b) To customers' specifications.
(c) Complete facilities.

LEADERSHIP!



WILCO

CRANE Keystone and Champion Gas Water Heaters rely on WILCO

A safety gas control is an essential part of a CRANE Gas Water Heater. For lasting service and safety, it must be dependable.

And that's why the manufacturer of CRANE Keystone and Champion Gas Water Heaters has standardized on Wilco Thermometal. Because, like so many hundreds of other leaders, Bastian-Morely Co., Inc., realizes there is no substitute for Wilco dependability, accuracy and sensitivity.

Pioneers in the development of thermometals as well as of electrical contacts, Wilco's experienced research staff stands ready to aid in whatever temperature control problem you may have. For a quicker, more economical solution write for "Wilco Blue Book of Thermometals and Electrical Contact Materials."

The H. A. Wilson Co., 105 Chestnut St., Newark, N. J. Branches: Detroit and Chicago

WILCO THERMOMETAL
(Thermostatic Bi-Metal)

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FOR SEALING
AND
LUBRICATING
BEARINGS

Not the Bible

But a Comprehensive Handbook on FELT SEALS *For Lubricants*

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EVERY *Randall* BEARING IS YOUR

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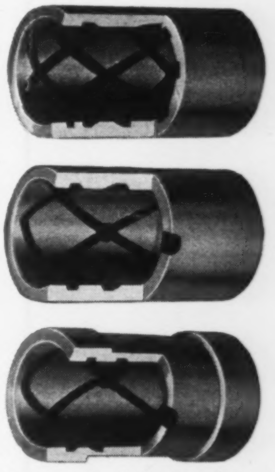
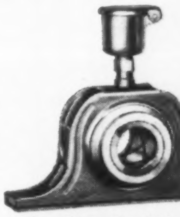
MAINTAINING EFFICIENT BEARING OPERATION UNDER ALL CONDITIONS

"On duty" every hour of the day for years on end, Randalls guard your equipment against bearing failure. In electric motors, washers, ironers, air-conditioning equipment, blowers, airplanes, tractors and a hundred other units in almost every type of machinery, they assure long, continuous, quiet, trouble-free operation in the field.



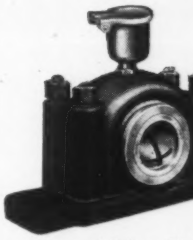
Cut-away sections of a few of many styles of Randall bushings



One-Piece Steel Housing Pillow Block

Graphite Bronze Bushings

Randall Patented Graphite Bronze Bushings have machined grooves permanently filled with porous lubricating graphite. The graphite-filled grooves not only provide, but retain, lubrication, and also act as capillary wicks when used in connection with oil reservoirs, providing controlled, proper and efficient lubrication to the shaft. Available in any required size and style.



Universal Pillow Block

Self-aligning
Self-lubricating
Pillow Blocks

Quiet, low in cost, easy to install, Randall Patented Pillow Blocks will serve dependably and efficiently for long periods in the field even with minimum attention. In the air-conditioning field Randall Pillow Blocks are standard on the majority of this equipment.

● ● ●

Flange Pillow Block

For over a third of a century Randall engineers have been designing and manufacturing bearings exclusively. Write today for helpful catalogs of bushings and pillow blocks.

RANDALL GRAPHITE PRODUCTS CORP.
DEPT. 1017, 609 W. LAKE ST., CHICAGO, ILL.

Custom Molders of Plastics

Reference letters beneath addresses of companies refer to: (a) Types of materials utilized; and (b) Names of machine parts customarily molded.

A

Ackerman Rubber & Plastic Molding Co., 986 E. 200th St., Cleveland.
(a) BAKELITE, DUREZ, BEETLE, PLASKON, TENITE, THIOKOL.
(b) Mechanical, electrical and industrial.

American Insulator Corp., New Freedom, Pa.
(a) BAKELITE, DUREZ, PLASKON, BEETLE, LUMARITH, TENITE, PLASTACELE, LUCITE and cold-molded composition.
(b) Knobs, buttons, balls, dials and handles.

American Molding Co., 16th and Vermont Streets, San Francisco.
(a) BAKELITE, DUREZ, BEETLE, PLASKON, TENITE, LUMARITH, RESINOX, FIBESTOS, CRYSTALITE, PLASTACELE, LUCITE, POLYSTYRENE.
(b) Technical, and automotive, etc.

American Phenolic Corp., 1250 W. Van Buren St., Chicago.
(a) BAKELITE, DUREZ, AMPHENOL, SUNEX, transparent POLYSTYRENE.
(b) Electrical small sections, special rods and tubes.

American Products Mfg. Co., 8127-33 Oleander St., New Orleans.
(a) TENITE, PLASTACELE, INCELOID and LUMARITH.
(b) Miscellaneous small parts not exceeding 4 oz.

Armstrong Cork Co., Industrial Div., Lancaster, Pa.
(a) CORPRENE.
(b) Gaskets, valve disks, cup packings, bushings, rolls, strips, sheets, etc.

Atlantic Plastics, 2730 Grand Ave., Cleveland.
(a) BAKELITE, BEETLE, PLASKON, DUREZ, RESINOX, TENITE, LUCITE, PLASTACELE, LUMARITH, THIOKOL and other synthetics.
(b) Safety supply parts, lighting and electrical, radio, chemical, mechanical, etc.

Auburn Button Works Inc., Auburn, N. Y.
(a) BAKELITE, DUREZ, RESINOX, BEETLE, PLASKON, TENITE, LUCITE.
(b) All types of machine parts.

B

Belmont Molded Plastics Inc., 400 Pike St., Cincinati.
(a) PLASTACELE, TENITE, LUMARITH, FIBERLON, LUCITE.
(b) All types of injection molded machine parts.

Berkander Inc., George F., 891 Broad St., Providence, R. I.
(a) TENITE, LUMARITH, PLASTACELE.
(b) To customers' specifications.

Boonton Molding Co., 326 Myrtle Ave., Boonton, N. J.
(a) BAKELITE, DUREZ, RESINOX, TENITE, PLASTACELE, LUCITE, CRYSTALITE STYRON, POLYSTYRENE, PLASKON, BEETLE.
(b) To customers' specifications.

Butterfield Inc., T. F., 56 Rubber Ave., Naugatuck, Conn.
(a) BAKELITE, DUREZ, MAKALOT, BEETLE, PLASKON, TENITE, LUMARITH, LUCITE, etc.
(b) Radio, heater switch, electrical, etc.

C

Cardinal Corp., Evansville, Ind.
(a) Any thermoplastic material.
(b) Specially finished injection moldings.

Chicago Die Mold Mfg. Co., 1735 W. Diversey Parkway, Chicago.
(a) TENITE, BAKELITE, PLASKON, LUCITE, STYRON, etc.
(b) To customers' specifications.

Chicago Molded Products Corp., 1028 N. Kolmar Ave., Chicago.
(a) BAKELITE, DUREZ, RESINOX, PLASKON, BEETLE, TENITE, LUMARITH, PLASTACELE, LUCITE, POLYSTYRENE.
(b) Automotive, industrial, mechanical, scientific, surgical, electrical.
See advertisement Page 71-D

Cleveland Plastics Inc., 12910 Taft Ave., Cleveland.
(a) BAKELITE, BEETLE, CRYSTALITE, DUREZ, ETHOCEL, LUCITE, LUMARITH, MONSANTO, PLASKON, PLASTACELE, RESINOX, STYRON, TENITE.
(b) To customers' specifications.

Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.
(a) All plastic materials.
(b) All types of machine parts.

Connecticut Plastic Products Co., 124 N. Elm St., Waterbury, Conn.
(a) TENITE, LUMARITH, PLASTACELE, BAKELITE-Acetate, LUCITE, POLYSTYRENE, CRYSTALITE, and other thermoplastic materials.
(b) Business machine parts, etc.

Continental-Diamond Fibre Co., Newark, Del.
(a) CELORON, DILECTO.
(b) Gears, couplings, aircraft parts, etc.

Cutler-Hammer Inc., 315 N. 12th St., Milwaukee.
(a) THERMOPLAX, PYROPLAX.
(b) Terminal blocks, insulators, switch bases, knobs, handles, insulating bushings, arc shields and miscellaneous electrical insulating forms.

D, E

Diemolding Corp., Canastota, N. Y.
(a) BAKELITE, DUREZ, PLASKON, BEETLE, TENITE or any other plastics of similar nature.
(b) Control handles or knobs, small bases and plates, housings, etc.

Eclipse Moulded Products Co., Milwaukee.
(a) BAKELITE, DUREZ, PLASKON, BEETLE, LUMARITH, LUCITE, TENITE, RESINOX.
(b) Valve handles, insulator parts, housings, transparent casings, knobs, switch buttons, control covers, agitators, cams and pulleys.

Erie Resistor Corp., 640 W. 12th St., Erie, Pa.
(a) TENITE, LUMARITH, LUCITE, STYRENE, PLASTACELE.
(b) Radio, refrigerator, automotive, handles, knobs, etc.

F, G

Firestone Rubber & Latex Products Co., Fall River, Mass.
(a) All compression and injection molding materials.
(b) Lenses, plastics over metal, automotive parts, cabinets and housings, electrical parts, etc.

General Electric Co., Plastics Dept., 1 Plastics Ave., Pittsfield, Mass.
(a) TEXTOLITE (molded, laminated and cold-molded).
(b) All types to customers' requirements.
See advertisement, Page 59-D

General Industries Co., International Insulating Div., Elyria, O.
(a) BAKELITE, DUREZ, RESINOX, PLASKON, BEETLE, TENITE, LUMARITH, PLASTACELE, LUCITE, CRYSTALITE. . . .
(b) Special parts to customers' specifications.

General Insulate Co. Inc., 11 New York Ave., Brooklyn.
(a) INSULATE, ureas, acetates, phenolics, acrylates.
(b) Insulators and insulating parts according to specification.

Gits Molding Corp., 4600 W. Huron St., Chicago.
(a) TENITE, LUMARITH, PLASTACELE, MASURON, LUCITE, BAKELITE, POLYSTYRENE.
(b) Radio knobs and cabinets, push-buttons, escutcheons, dials, supports and insulators.

Globe Tool & Molded Products Co., 1032 Mulberry St., Rockford, Ill.
(a) BAKELITE, MAKALOT, DUREZ, RESINOX, BEETLE and PLASKON.
(b) To customers' specifications.

H, I

Haveg Corp., Newark, Del.
(a) HAVEG.
(b) Acid-resistant equipment, standard tanks, piping, fittings, fume duct, towers, etc.

Insulation Mfg. Co. Inc., 11 New York Ave., Brooklyn.
(a) Acetates, phenolics, acrylates and Electros.
(b) Insulators and insulating parts.

Insulation Products Co., 504 North Richland St., Pittsburgh.
(a) BAKELITE, DUREZ, TENITE, PLASKON.
(b) Parts to customers' specifications.

K

Keolyn Plastics Co., 2731 N. Pulaski Rd., Chicago.
(a) PLASTACELE, TENITE, LUCITE, POLYSTYRENE, LUMARITH and other thermoplastics for injection molding. Fully equipped to fabricate cast plastics by machining.
(b) Knobs, handles, housings and special parts.

Into Plastics without knowing where you are going.

You need an intelligent and unbiased guide to conduct you through the maze of new plastic molding materials and methods.

Which plastic material is best for your product?
Which molding method should be employed?
What is your most economical mold set up?

These are questions that only an experienced molder can help you answer. Answer so as to save you time and money, and insure your getting satisfactory plastic molded parts.

CHICAGO MOLDED PRODUCTS has more than experience,—we have the skilled personnel and plant facilities to meet your most exacting specifications and timely delivery requirements for plastic molded parts.

Here you find no divided responsibility, for we not only design and fabricate the mold, but mold all types of plastic materials.

We have ample press equipment for both compression and injection molding.

Try us on your next job

CHICAGO MOLDED PRODUCTS CORP.

1028 NORTH KOLMAR AVENUE
CHICAGO, ILLINOIS

Keystone Specialty Co., 1373½ Cove Ave., Lakewood, O.
(a) Any material to customers' specifications.
(b) Parts to customers' specifications.

Kuhn & Jacob Moulding & Tool Co., 1200 Southard St., Trenton, N. J.
(a) BAKELITE, DUREZ, BEETLE, PLASKON, TENITE, LUCITE, LUMARITH, etc.
(b) Compression molding of electrical, automotive, radio, airplane, instrument, permanent wave machine parts, etc.

Kurz-Kasch Inc., 1415 S. Broadway, Dayton, O.
(a) BAKELITE, DUREZ, BEETLE, PLASKON, LUMARITH, TENITE, CRYSTALITE, LUCITE.
(b) Shift balls, general insulating parts, both mechanical and electrical.

L

Lanfare Molded Products, 1519 Freeman St., Toledo, O.
(a) PLASKON, DUREZ, MAKALOT.
(b) Electrical instrument cases, radio, etc.

M

Mack Molding Co. Inc., Ryerson Ave., Wayne, N. J.
(a) BAKELITE, DUREZ, TENITE, BEETLE, LUMARITH, FIBESTOS, PLASKON.
(b) Parts to customers' specifications.

Meissner Mfg. Co., Mt. Carmel, Ill.
(a) Any phenolic or thermosetting materials.
(b) Insulators, handles, bushings, gears, bearings, etc.

Michigan Molded Plastics Inc., G and Baker Sts., Dexter, Mich.
(a) BAKELITE, DUREZ, TENITE, PLASTACELE, LUMARITH, PLASKON, LUCITE.
(b) Molded plastic parts, all types and sizes by compression, injection and extrusion.

Molded Insulation Co., 335 E. Price St., Philadelphia.
(a) BAKELITE, DUREZ, RESINOX, DURITE, BEETLE, PLASKON, TENITE, LUCITE.
(b) Aircraft, radio, electrical and other machine parts and assemblies.

N

National Lock Co., Rockford, Ill.
(a) BAKELITE, BEETLE, PLASKON, DUREZ, TENITE.
(b) Handles, pulls, stove and refrigerator trim.

Northern Industrial Chemical Co., 7 Elkins St., South Boston, Mass.
(a) BAKELITE, DUREZ, BEETLE, PLASKON, TENITE, LUMARITH, etc.
(b) Any molded part to customers' specifications.

Norton Laboratories Inc., 520 Mill St., Lockport, N. Y.
(a) BAKELITE, DUREZ, PLASKON, BEETLE, TENITE, LUMARITH, LUCITE, CRYSTALITE, PLASTACELE.
(b) Housings, terminals, bushings, wheels, knobs, handles, etc.

P

Pyro Plastics Co., The, 526-532 North Ave. East, Westfield, N. J.
(a) TENITE, PLASTACELE, LUMARITH, FIBESTOS, POLYSTYRENE, LUCITE, CRYSTALITE.
(b) To customers' specifications.

R

Recto Molded Products Inc., Appleton and B. & O. R. R., Oakley, Cincinnati.
(a) DUREZ, BAKELITE, TENITE, LUMARITH, RESINOX, PLASKON.
(b) All types to customers' specifications.

Reinhold, F. E., 7001 McKinley Ave., Los Angeles.
(a) BAKELITE, BEETLE.
(b) Electrical parts, radio cabinets, etc.

Reynolds Molded Plastics Div., Reynolds Spring Co., Cambridge, O.
(a) BAKELITE, PLASKON, TENITE, LUMARITH, BEETLE, DUREZ, LUCITE.
(b) All types to customers' specifications.

Richardson Co., The, 27th and Lake Sts., Melrose Park, Chicago.
(a) INSUROK, EBROK, RUB-TEX, RUBEROK, MICAROK.
(b) All types to customers' specifications.
See advertisement, Page 14-D

Royal Moulding Co., 69 Gordon Ave., Providence, R. I.
(a) BAKELITE, RESINOX, DUREZ, PLASKON, BEETLE, MAKALOT.
(b) Electrical appliance housings.

S

Sheller Mfg. Co., Portland, Ind.
(a) TENITE, LUMARITH, PLASTACELE, RESINOX, BAKELITE, and miscellaneous plastics.
(b) Automotive and miscellaneous.

Sinko Tool & Mfg. Co., 351 N. Crawford Ave., Chicago.
(a) TENITE Nos. 1 and 2, POLYSTYRENE, LUMARITH, PLASTACELE, FIBRELOID, LUCITE, CRYSTALITE, also metal reinforced thermoplastics.
(b) Radio and automotive knobs, pushbuttons, escutcheons, bezels, etc.

Specialty Insulation Mfg. Co. Inc., Hoosick Falls, N. Y.
(a) COLASTA, BAKELITE, DUREZ, TENITE, BEETLE, PLASKON, etc.
(b) Business machines parts, etc.

Stokes Rubber Co., Jos., Taylor and Webster Sts., Trenton, N. J.
(a) BAKELITE, DUREZ, BEETLE, PLASKON, LUMARITH, TENITE.
(b) All types to customers' specifications.

Stricker-Brunhaber Corp., 19 W. 24th St., New York.
(a) BAKELITE, CATALIN, TENITE, and rubber, wood and transparent plastics.
(b) To customers' specifications.

T, V

Ther Electric & Machine Works, 17 S. Jefferson St., Chicago.
(a) DUREZ, BAKELITE, PLASKON, etc.
(b) To customers' specifications.

Van Norman Molding Co., 6437, S. State St., Chicago.
(a) BAKELITE, DUREZ, PLASKON.
(b) Knobs, handles and insulating parts.

W

Ward Plastic & Rubber Co., 1037 Hilton Rd., Ferndale, Mich.
(a) All thermoplastic and thermosetting materials.
(b) Condulet boxes, coil bobbins, bearings, handles, oil seals, pump parts such as washers, seals, stators, various electrical parts, etc.

Warren Plastics Corp., Warren, Pa.
(a) BAKELITE, DUREZ, RESINOX, BEETLE, PLASKON, MASURON.
(b) Small machine parts.

Waterbury Button Co., The, 39 River St., Waterbury, Conn.
(a) BAKELITE, DUREZ, BEETLE, PLASKON, TENITE, LUCITE, SHELLAC COMPOSITION, LUMARITH, RESINOX, CRYSTALITE, POLYSTYRENE, etc.
(b) All types to customers' specifications.

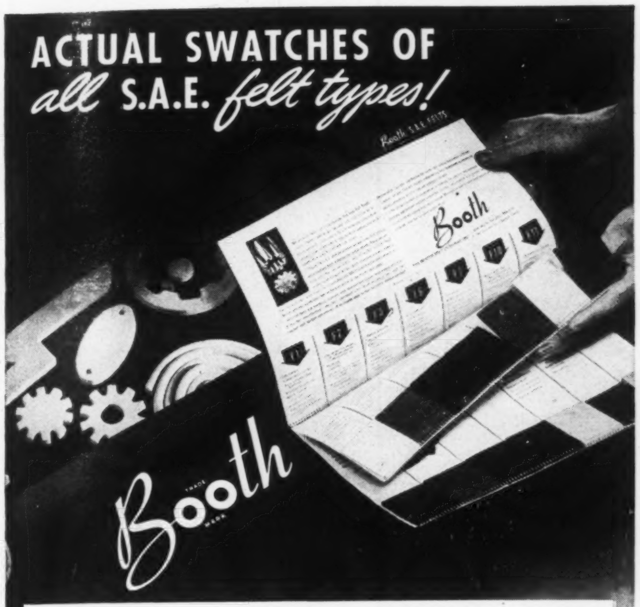
Watertown Mfg. Co., 138 Echo Lake Rd., Watertown, Conn.
(a) NEILLITE, BAKELITE, DUREZ, RESINOX, TENITE, LUMARITH, FIBESTOS, PLASTACELE, LUCITE, BEETLE, PLASKON.
(b) Contact blocks, insulator blocks, switch housings, cams, spacers and any other moldable plarts.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
(a) MICARTA.
(b) To customers' specifications.

White Dental Mfg. Co., The S. S., Plastics Dept., 10 E. 40th St., New York.
(a) TENITE, LUMARITH, LUCITE, CRYSTALITE, POLYSTYRENE.
(b) Automotive, electrical, etc.

Windman Brothers, 3325 Union Pacific Ave., Los Angeles.
(a) BAKELITE, DUREZ, PLASKON, BEETLE, all phenolics and ureas; Styrenes, acrylic resins and TENITE or cellulose acetates.
(b) Electric razor cases, radio cabinets, electrical, mechanical, dental, photographic and surgical equipment parts.

ACTUAL SWATCHES OF *all* S.A.E. *felt types!*



Mailed free to any felt user, this combination Application Chart and Sample file-folder not only samples the 14 S.A.E. felt types. . . . It also classifies approved felt uses throughout Industry. Contains the S.A.E. specification tables, too. A valuable reference work (bound in standard file size) which makes your choice of the correct felt easy, in all applications where felt serves *better*. No obligation or sales follow-up. Write today.

BOOTH FELT COMPANY, INC., 444 19th St., Brooklyn, N. Y., 732 Sherman St., Chicago, Ill.
[Established 1905]

1422

You can't wear this slipper!

The drop forging above is a slipper for a 40 m.m. tank gun, part of the recoil mechanism, made for an armament manufacturer. It's just one of many steam hammer, drop and upset forgings for defense purposes being made by Kropp.

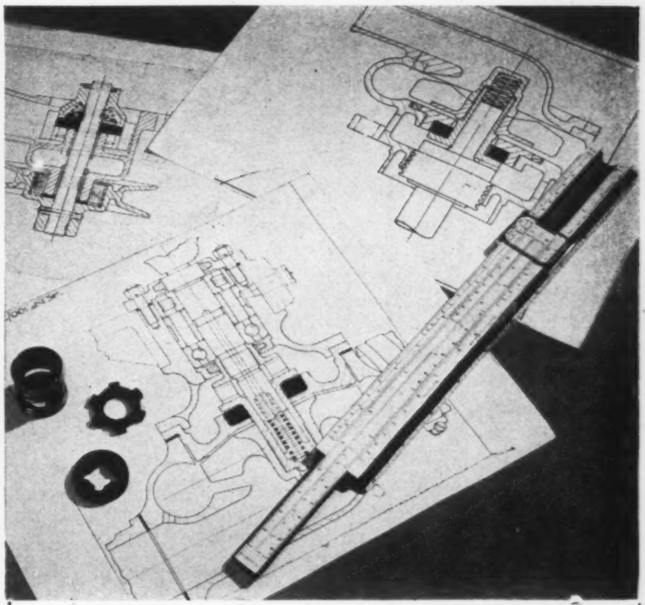
We're doing our part, *BUT* we have not forgotten our regular customers. We believe business should go on in its normal channels as much as possible to provide stability. We haven't "side-tracked" regular business.

It is just such consideration for its valued customers that has made Kropp the World's Largest Job Forging Shop. Come heat, havoc or high water, Kropp's customers get their forgings—rough, heat-treated or machined—on time and exactly according to specifications.

Why not send your next forgings order to Kropp!

KROPP

KROPP FORGE COMPANY
WORLD'S LARGEST JOB FORGING SHOP
5307 W. Roosevelt Road, Chicago, Illinois
REPRESENTATIVES IN PRINCIPAL CITIES



- *What sealing material is used on most popular automobile pumps to-day?*

MORGANITE MM1!

- *Who solved the sealing of oil and chemicals in many industrial pumps?*

MORGANITE!

- *Where can you learn more about these materials?*

Write for a copy of "Morganite's Modern Black Magic", or ask to have our engineer visit you

MORGANITE
Modern Black Magic

MORGANITE BRUSH CO., INC.
LONG ISLAND CITY NEW YORK

Machine Finishes Producers

Reference letters beneath addresses of companies refer to: (a) Tradename and type of finish, availability in color; (b) Method of application and drying; and (c) Characteristics and use of finish.

A

Akron Paint & Varnish Co., Firestone Parkway, Akron, O.
(a) Enamel in all colors.
(b) For brushing and spraying; air drying and baking.
(c) Decorative and rustproofing; heavy machinery.

Alrose Chemical Co., P. O. Box 1294, Providence, R. I.
(a) JETAL, for obtaining black finish on ferrous metals.
(b) For dipping; air drying.
(c) Decorative, rustproofing, heat resisting; for machines, appliances.

Aluminum Co. of America, Gulf Bldg., Pittsburgh.
(a) ALUMILITE (Aluminum oxide) plain and colored; ALROK, colorless or color.
(b) Electrolytic.
(c) Decorative, protective, high dielectric strength; for application to aluminum parts.
See advertisement, Page 13-D

American Chemical Paint Co., Ambler, Pa.
(a) THERMOIL GRANODINE phosphate coating chemical; KEMICK chemical paint; available in Matte gray.
(b) For hot dipping, and drying by compressed air, etc.
(c) Wear, rust and heat resistant; for use on automobile engine parts, gears, bearing surfaces, etc.

American-Marietta Co., 43 East Ohio St., Chicago.
(a) VALDURA enamel, available in certain colors.
(b) For brushing or spraying; air drying.
(c) Decorative, rustproofing, heat and vibration resistant; for turbines, generators, motors, lathes, etc.

American Waterproofing Corp., 47 Rodney St., Brooklyn.
(a) AMPRUF finish, in variety of colors.
(b) Brush or spray; air or low temperature bake.
(c) Decorative, rustproofing, water and oil resistant; for all types of machines, pumps, presses, etc.

Arco Co., The, 7301 Bessemer, Cleveland.
(a) ARCO lacquers, synthetics and oil enamels; available in standard machine tool gray or special shades.
(b) Adaptable for any application method; air or force dried.
(c) Rust, heat and oil resistant; for all industrial machinery.

Ault & Wiborg Corp., 75 Varick St., New York.
(a) POLYMERIN speed-bake enamel, WRINKLE enamel, and AULTONE lacquers; available in all colors.
(b) POLYMERIN and WRINKLE for spraying and dipping, and baking (all methods including infra-red); AULTONE applied by knife or sprayed, and air dried.
(c) Decorative, protective, heat and cold resistant; for any part suitable for baking.
See advertisement, Page 51-D

B

Baer Brothers, 438 West 37th St., New York.
(a) Air drying finishes—glossy, semiglossy and flat; baking finishes in all sheens; wrinkle finishes and lacquers; available in color.
(b) For brush, spray, flow and dip; air dried and baked.
(c) Decorative and protective, for practically all types of machinery.

Bownes, Frank, Co., Chelsea, Mass.
(a) MODENE, mill whites and synthetic enamels and special finishes.
(b) For spray, brush and dip; air dried and baked.
(c) Decorative and protective; for machine tools.

Bradley, C. E., Laboratories Inc., Elm St., Brattleboro, Vt.
(a) BRADLEY paints, lacquers, enamels, varnishes, and synthetics; available in color.
(b) For brush, spray and dip; air dried or baked.
(c) Decorative, rustproofing, heat resistant; for all types of machines.

Brown, Andrew, Co., 5431 S. Riverside Dr., Los Angeles, Calif.
(a) SYNFLEX synthetic enamel in any color; BROLITE lacquer in any color.
(b) Enamel sprayed or brushed, evaporation followed by oxidation; lacquer brushed or sprayed, quick drying by evaporation.
(c) Decorative, rustproofing and heat resistant; for practically all types of machinery.

C

Carpenter-Morton Co., 77 Sudbury St., Boston.
(a) COMBATIT rust inhibitive primer in greenish gray or darker.
(b) Can be applied by any method; air dried.
(c) Rustproofing of iron and steel; for all machines subjected to more than ordinary moisture conditions.

Central Paint & Varnish Works, 63-69 Prospect St., Brooklyn.
(a) CENTRAL synthetic porcelainized machinery finish; CENTRAL machinery enamel; available in colors.
(b) For brush, spray or dip; air dry.
(c) Decorative, rustproofing and cleanliness; for all types of machinery exposed to scrutiny of public.

Chromium Corp. of America, 120 Broadway, New York.
(a) CRODON chromium plating (also copper, nickel, etc.); in metallic colors only except for special processes.
(b) Electroplating.
(c) Decorative, rustproofing, hardness; for various types of machines.

D

Day, James B., & Co., 1872 Clybourn Ave., Chicago.
(a) NITROLITE lacquer enamel; and a synthetic baking enamel.
(b) Lacquer sprayed or dipped and air dried; enamel sprayed and baked.
(c) Decorative; for any type of metal machine part.

Detroit Plating Industries, 1033 Mt. Elliott Ave., Detroit.
(a) Chromium, copper, nickel, cadmium and zinc finishes, not available in color.
(b) Electrolytic.
(c) Decorative and rustproofing; for various types of machines.

Dibble Color Co., 1497 East Grand Blvd., Detroit.
(a) DIBBLE standard machinery finishes in gray, black, white and red.
(b) For brushing and spraying; air drying and baking.
(c) Rustproofing; for milling and broaching machines, lathes, presses, etc.

Di-Noc Mfg. Co., 1700 London Rd., Cleveland.
(a) DI-NOC lacquer involving special process to reproduce wood grains and other effects.
(b) May be applied to steel, wood and composition material, or furnished in form of prefinished sheets.
(c) Heat, cold and salt spray resistant; for radios, air conditioning units, business machines and similar equipment.

E

Enterprise Galvanizing Co., 2507 East Cumberland St., Philadelphia.
(a) Hot dip zinc galvanizing; in silvery color, spangled or nonspangled.
(b) Hot dipping in molten zinc.
(c) Rustproofing; for laundry machinery, refrigerators, air conditioning, or wherever moisture or atmospheres attack.

F

Felton Sibley Co., Inc., 136 N. 4th St., Philadelphia.
(a) Machinery paint and enamel; available in color.
(b) For brush and spray; air dry.
(c) Decorative, rustproofing, heat resistant; for machine tools, canning machines, turbines, etc.

Ferro Enamel Corp., 4150 East 56th St., Cleveland.
(a) FERRO porcelain enamel; in all colors and shades.
(b) For spray; hot air dried.
(c) Decorative, rustproofing, cleanliness; for food, chemical processing, textile machinery, etc.

H

Hague, Alfred, & Co. Inc., 227—34th St., Brooklyn.
(a) RUBALT No. 269 enamel; available in custom colors.
(b) Can be applied by any method; air dried or low baked.
(c) Rustproofing; for any type of machinery.

Harrop Chemical Co., 135 Hoboken Ave., Jersey City, N. J.
(a) HARROP ENAMEL 15 and HARROP ONE HOUR ENAMEL; both available in colors.
(b) Enamel 15 applied by brush and air dried in 15 min.; One Hour Enamel, by brush or spray, and air dried.
(c) Decorative and rustproofing; any type of machine.

Haynes, C. W., Laboratory Inc., Chandler St., Springfield, Mass.
(a) LABKOTE synthetic enamel; in any color.
(b) For brush or spray; air dry.
(c) Quick-drying, decorative; for any type of machine.

Heatbath Corp., Springfield, Mass.
(a) PENTRATE hot water solution; in black.
(b) For dip or spray (special); air or sawdust dried.
(c) Decorative, rustproofing, friction reducing; for any machine part of steel.

Heresite & Chemical Co., Manitowoc, Wis.
(a) HERESITE enamel, in all colors.
(b) Spray, dip, brush; baked.
(c) Acid, alkali resistant, dielectric strength; for any type of machine requiring foregoing characteristics.

Hilo Varnish Corp., 42 Stewart Ave., Brooklyn.
(a) HILO paints, lacquers, enamels, varnish, etc., also Black Japans, in all colors; and HILO 350 Vitra Carlite in any color.
(b) Hilo paints, etc. applied by any method; 350 Vitra Carlite by spraying and dipping.

NATIONAL ENGINEERS *make it easy for you* to select the *Right* Laminated Materials

TWO well-known National Engineers, James C. Otis and Joseph S. Tatnall, are shown testing Combination Fibre and Phenolite, laminated Bakelite, tubing for bursting strength due to transient internal pressure. The Impact Tester duplicates fuse blowing under heavy load, and closely approximates the effect of a lightning stroke. Designed and constructed by NATIONAL Engineers, it is one of the many devices used to help you select the Laminated material which will best serve your specific problem.

Take advantage of the research service we offer you. There's no obligation. We have cut costs and increased profits for many, many manufacturers. Perhaps we can do it for you, too. Write us today.

NATIONAL VULCANIZED FIBRE

PHENOLITE
Laminated BAKELITE

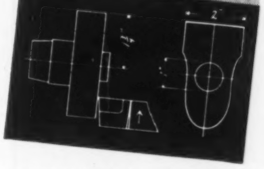
PEERLESS INSULATION

NATIONAL VULCANIZED FIBRE COMPANY
WILMINGTON, DELAWARE AND PRINCIPAL CITIES

WOULD MANGANESE STEEL BE DESIRABLE in *Your* MACHINE PARTS?

Here's how KENNAMETAL Tools can hold down production costs:

Manganese Steel, which is desirable for many applications due to its hardening characteristics, presents a real machining problem. The short tool life obtained with other cutting materials makes KENNAMETAL practically indispensable if machining costs must be kept in line.



KENNAMETAL turned and faced this T 1350 Manganese Steel forging in 3 minutes floor to floor time.

The injector body illustrated is made of T 1350 Manganese Steel forgings, 25-28 Rockwell C, yet KENNAMETAL turned and faced 40 of these pieces per grind of tool with 3 minutes floor to floor time per piece. Compared to the High Speed Steel Tools formerly used, KENNAMETAL produced nearly three times more pieces per grind in one-half the floor to floor time per piece.

Let us show you how KENNAMETAL enables you to specify any alloy steel you desire for your machine parts . . . while holding machining costs to a minimum. No obligation—write today.

KENNAMETAL tools cost no more than ordinary carbide tools —see our new price schedule.

McKENNA METALS Co.
146 LLOYD AVENUE
LATROBE, PENNSYLVANIA, U.S.A.

Molded Synthetic Rubber Products Meet Current Production Problems

The laboratories of Western Felt Works have developed new and effective synthetic rubber products and felt-synthetic rubber combinations, which are being used with great success.

Gaskofelt is a combination of felt-oil resistant rubber compound used for gasketing in connection with oil, steam and hot and cold water; Westfeltopak is a gasketing material of felt, coated on all sides with a synthetic rubber resistant to many oils, gasoline, alcohols, etc.; Resistofelt is a combination of felt and Neoprene —preventing the passage of oil; Acadia Synthetic Rubber Products are produced in various formulas in molded form for use where high heat and oil are encountered or where water and solvents are present.

Write our Engineering Department

ACADIA SYNTHETIC PRODUCTS DIVISION

WESTERN
FELT WORKS
Manufacturers and Cutters of Wool, Jute and Hair Felt
4037-4117 Ogden Avenue Chicago, Illinois
Branch Offices in All Principal Cities

(c) Paints are used for decoration and rustproofing for all types of machines; 350 Vitra Carlite for decorative and rustproofing purposes on any machine where finish is to withstand 350 degrees Fahr.

Hommel, O., Co., 209 Fourth Ave., Pittsburgh.
(a) HOMMELAYA process of vitreous enameling in any color or shade.
(b) For spray or dip; drier equipment.
(c) Decorative, rustproof or heat resistant; for any type of machine.

Hooker Glass & Paint Mfg. Co., 651 Washington Blvd., Chicago.
(a) KING machine and engine enamel available in color; No. 6132 standard machine tool gray enamel.
(b) For brush or spray; air dry.
(c) Decorative, protective; King enamel for gas engines, steam engines, presses, machine tools, dynamos, etc.; No. 6132 for woodworking and metalworking machinery.

Hunsley Paint Mfg. Co., 1701 West Seventh St., Amarillo, Texas
(a) SILVER "7" enamel, in all colors.
(b) For brush, spray, flow or dip; air dried.
(c) Decorative, protective; on any type of machine.

I

Illinois Bronze Powder Co., 564 W. Monroe St., Chicago.
(a) ILLBRONZE BRAND chrome finish aluminum paints, available in silver chrome (varnish base).
(b) For brush, spray, flow or dip; air dried or baked.
(c) Decorative, heat resisting, rustproofing; on any type machinery.

Irvington Varnish & Insulator Co., Inc., 6 Argyle Terrace, Irvington, N. J.
(a) HARVEL; available in all standard colors.
(b) Applied by brush.
(c) Decorative, acid and alkali resistant, heat resistant; for pumps, electric motors, etc.

J

Johnson, S. C., & Son Inc., Racine, Wis.
(a) WAX-O-NAMEL, combination of synthetics, wax and color pigments, available in 19 shades and standard machine tool gray. CAVEL finish, combination synthetics, bronze powder and color pigments; in gunmetal gray, brown, blue, copper, gold and other metallic effects.
(b) Wax-O-Namel applied in all methods; air dried, low heat slow bake, high heat short bake. Cavel sprayed and splattered for hammered effect air dried or baked.
(c) Both decorative, protective, heat and oil resistant; for all types of machinery.

K

Koppers Co., Tar and Chemical Div., Pittsburgh.
(a) LUMINO paint with bituminous base and aluminum finish, in aluminum only; KOPPAX paint in black only; LOCOMAX paint in black or dark gray.
(b) Lumino and Locomax sprayed or brushed, Koppax brushed only.
(c) Lumino used for decoration, rustproofing and heat resistance; for pipe coverings, boilers, evaporators, ovens, railway and mine cars, etc. Koppax used for dampproofing, rustproofing, heat resistance, corrosion resistance; for industrial machinery, etc. Locomax is used for decorative and rustproofing purposes in railway locomotives.

Krome-Alume Inc., 241 Bewley Bldg., Lockport, N. Y.
(a) KROME-ALUME plated aluminum finish.
(b) For plating.
(c) Decorative, rustproofing; in any type of machine.

L

Lehon Co., 4425 South Oakley, Chicago.
(a) MULE-HIDE asphaltic aluminum paint, in aluminum only.
(b) For brush, spray, dip; air dry.
(c) Decorative and rustproofing; used on woodworking or metalworking machines.

Liquid Plastic Corp., 4150 East 56th St., Cleveland.
(a) VEDOC synthetic finish; available in black and white only.
(b) For spraying and dipping; baked.
(c) Decorative and protective; for washing machines, refrigerators, etc.

M

Maas & Waldstein Co., 438 Riverside Ave., Newark, N. J.
(a) METALUSTRE lacquer enamels and synthetic enamels available in 28 standard colors; RAYDUR synthetic enamels in most colors; DUART WRINKLE enamels in most colors; CODUR enamels in colors; and DYKAST lacquer enamels in most colors.
(b) Metalustre, spray, air dry and bake; Raydur, spray or dip, bake (Infra-red) ovens; Duart, spray; Codur, spray or dip; and Dykast, spray and dip, air dry.
(c) Decorative and protective coatings; Metalustre is used for sheet metal work and castings; Raydur on any machine requiring a tough, durable finish; Duart for cabinets and metal or Bakelite parts that can be baked; Codur for any type of machine requiring moisture and chemical resistant finish; and Dykast for zinc and aluminum die castings.

Martin Varnish Co., 900 W. 49th Place, Chicago.
(a) MAR-VEL-FILM enamel, available in colors. AMBERLYTE aluminum paint.
(b) Mar-Vel-Film, brush or spray, air dry; Amberlyte, brush or spray, air or force dry.
(c) Mar-Vel-Film is decorative for machinery not subject to exterior exposure or temperatures above 400 deg. Fahr.; Amberlyte is heat resistant and rustproof, for all machinery.

Monsanto Chemical Co., Merrimac Div., Everett Sta., Boston.
(a) MERTEC and R-4000; both lacquers available in color.
(b) Both applied by spray or brush; air dried.
(c) Corrosion resistant; for chemical plant machinery, laundry and mill machinery, etc.

Murphy Varnish Co., 224 McWhorter St., Newark, N. J.
(a) VITRALYN enamel and SHRIVEL FINISH enamel, both available in color.
(b) Both spray or dip; baked (high heat-short bake for Vitralyn also).
(c) Vitralyn is for decorative and protective purposes, for castings, stampings, office equipment, machine tools, and general machinery. Shrivel Finish is decorative for office equipment, machine tools, castings and stampings.

N

New Jersey Lacquer Co. Inc., 4400 Dell Ave., North Bergen, N. J.
(a) PYROLAC lacquer, synthetic coatings; available in all colors.
(b) For spray, dip, brush; air dry and bake.
(c) Decorative, heat resistant, rustproofing; for cinema projectors, cameras, typewriters, scales, electric irons, etc.

New Wrinkle Inc., Dayton, O.
(a) WRINKLE enamel in all colors.
(b) Applied by spraying; oven or Infra-red dried.
(c) Decorative and protective; for all types of machines.

O

Oakley Paint Mfg. Co., 727 Antonia St., Los Angeles.
(a) BATEX synthetic enamel in all colors; OIL TOOL LAKKER, synthetic lacquer, in all colors.
(b) Batex, spray or dip and air dried or baked; Oil Tool Lakker, brush, spray or dip and air dried in 15 min.
(c) Batex is wear resistant for machines requiring high grade finish; Oil Tool Lakker is quick-drying, durable finish used on any machine but mostly in oil fields.

P

Parker Rust-Proof Co., 2177 East Milwaukee, Wis.
(a) PARKERIZING and BONDERIZING.
(b) Spray or dip; force drying.
(c) Rustproofing and as a base for paint, lacquer, enamel and oil finishes; for all types of machines.

Peninsular Paint & Varnish Co., 8250 St. Aubin Ave., Detroit.
(a) KLEEN-EZY and PENPROX, paint, varnish, enamel and lacquer; in all colors.
(b) For brush, spray or dip; air drying or baking.
(c) Decorative, rustproofing, heat resisting, etc.; for all types of machinery.

Porcelain Enamel & Mfg. Co., Eastern & Pemco Ave., Baltimore.
(a) PEMCO porcelain enamels, in any color.
(b) For spray and dip; continuous dryer.
(c) Decorative and rustproofing; for all types of machines.

Porcelain Metals Inc., 28-20 Borden Ave., Long Island City, N. Y.
(a) SUPORCEL porcelain enamel.
(b) For spraying; hot air, then firing at 1550 degrees Fahr.
(c) Decorative, where sanitation and easy cleaning is required.

Pyrene Mfg. Co., 560 Belmont Ave., Newark, N. J.
(a) UDYLITE, cadmium finish, in silvery-white; PYRENE BRIGHT ZINC in gray; PYRENE BRIGHT NICKEL, thick deposits of high brilliance; BONDERITE, in black; PYRENE CHROMIUM; ALUMILITE; PARKERIZING, silvery to variety of black finishes.
(b) Udylite, Pyrene Bright Zinc, Bright Nickel and Chromium plating; Bonderite immersion; Alumilite, electrolytic; Parkerizing chemical displacement without changing dimensions or physical characteristics.
(c) Udylite for rustproofing and decoration of machines with steel parts subject to rusting; Pyrene Bright Zinc for protection on variety of machines. Pyrene Bright Nickel for decoration, protection and base for chromium plating. Pyrene Chromium for decoration, rustproofing and wear resistance on machines having decorative parts or requiring longer life of parts subject to wear. Bonderite for rustproofing of machines with steel parts. Alumilite for decoration and protection of machines having aluminum parts. Parkerizing for rustproofing and decoration of machine parts.

R

Reilly Tar & Chemical Corp., 1615 Merchants Bank Bldg., Indianapolis.
(a) RESISCOTE paint, in gray, etc.
(b) Brush or spray; air dried or baked.
(c) Rustproofing, protection against corrosive gases, etc.; for all types of machines.

Roxalin Flexible Lacquer Co., 806 Magnolia Ave., Elizabeth, N. J.
(a) ROXAPRENE synthetic enamel, in all colors; RINCONTROL wrinkle enamel, in practically all colors.
(b) For spraying and dipping; Rincontrol only for spraying.
(c) Both are decorative and corrosion resistant; Roxaprene used for air conditioning equipment, etc.; Rincontrol used for business and electrical appliances.

S

Sherwin Williams Co., 101 Prospect Ave., Cleveland.
(a) KEM ENAMELS; also paints, varnishes and lacquers to suit individual requirements, and heat resistant finishes.
(b) Brush, spray or dip; air drying or baking.
(c) For application to all types of machines.

Simoniz Co., 2100 Indiana Ave., Chicago.
(a) COROL semi-hard removable anticorrosive.
(b) For spray, dip, brush; air dried, non-oxidizing.
(c) For rust and corrosion prevention of all types of machines.

T

Thomson Wood Finishing Co., 829 N. 3rd St., Philadelphia.
(a) PORCELITE enamels, wide variety of colors.
(b) Available for all methods of application and drying.
(c) Decorative and protective; for all types of machines.

Triskalite Corp., 67 Wall St., New York.
(a) TRISKALITE chromium plating; available in a silvery white color, devoid of usual blue cast.
(b) Plating.
(c) Rustproofing, wear resistance, decorative, heat resistance, etc.; used wherever chrome plating is desirable.

Tropical Paint & Oil Co., 1276 West 70th St., Cleveland.
(a) TROPELITE varnish (100 per cent Bake-

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OCTOBER, 1940

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To Reduce Abrasive and Corrosive Wear

on such parts as:

Guides for the wire, paper, textile and shoe industry

Valve stems and seats for hydraulic presses and devices

Meter fingers and pawls

Chilling plates for the hardening and tempering of their stock

Mould liners for pharmaceutical, ceramic and powdered metal arts

Grinder parts for fine grinding of paint pigments, carbon products, etc.

. . . and many other machine parts subject to excessive wear.

In addition to its well known use for cutting tools and drawing and sizing dies, Carboloy cemented carbide has a wide potential field of use as a medium for the reduction of excessive wear caused by corrosion or abrasion, on machine parts.

As an abrasion resistant metal Carboloy cemented carbide has proven its ability to resist localized frictional wear and wear from many abrasive substances.

As a corrosion resistant metal Carboloy cemented carbide is known to have a high degree of resistance under all known atmospheric conditions. Its use to date also indicates desirable corrosion resistant qualities when exposed to acids and alkalies.

Our metallurgists are in a position to offer constructive assistance on such problems in your plant.

CARBOLOY COMPANY, Inc.
DETROIT, MICHIGAN
Chicago—Cleveland—Newark—Philadelphia—Pittsburgh
Worcester, Mass.—Los Angeles

CARBOLOY CEMENTED CARBIDES

lite), available in clear, black and gray; ELASTIKOTE aluminum paint.

(b) Tropelite can be applied by any method and is air dried; Elastikote by brush or spray, also air dried.

(c) Tropelite is alkali, acid and moisture-proof and Elastikote is decorative, rustproofing and heat resistant; both can be used on all kinds of machinery.

U

United Platers Inc., 991 Madison Ave., Detroit.

(a) UNIMATIC chrome, nickel, copper, cadmium, tin, zinc, stainless steel, aluminum, etc., finish.

(b) Plating, dipping, tumbling, natural and oxidized finishes.

(c) Decorative, rustproofing, wear and heat resistant; for use on all kinds of machines.

V

Vitreous Steel Products Co., 6700 Grant Ave., Cleveland.

(a) VITREO porcelain enamel in every color.

(b) Dip or spray; gas heated tunnel dryers.

(c) Chemical and heat resisting, sanitation, etc., for food machinery and in process industries.

W

Willey, C. A., Co., 10-29—44th Rd., Long Island City, N. Y.

(a) SPEEDSPRAY synthetic enamel and synthetic clear varnish; in 40 standard shades.

(b) Brush and spray; air dry, force dry and bake.

(c) Decorative; for machine tools, oil burners, refrigerators, etc.

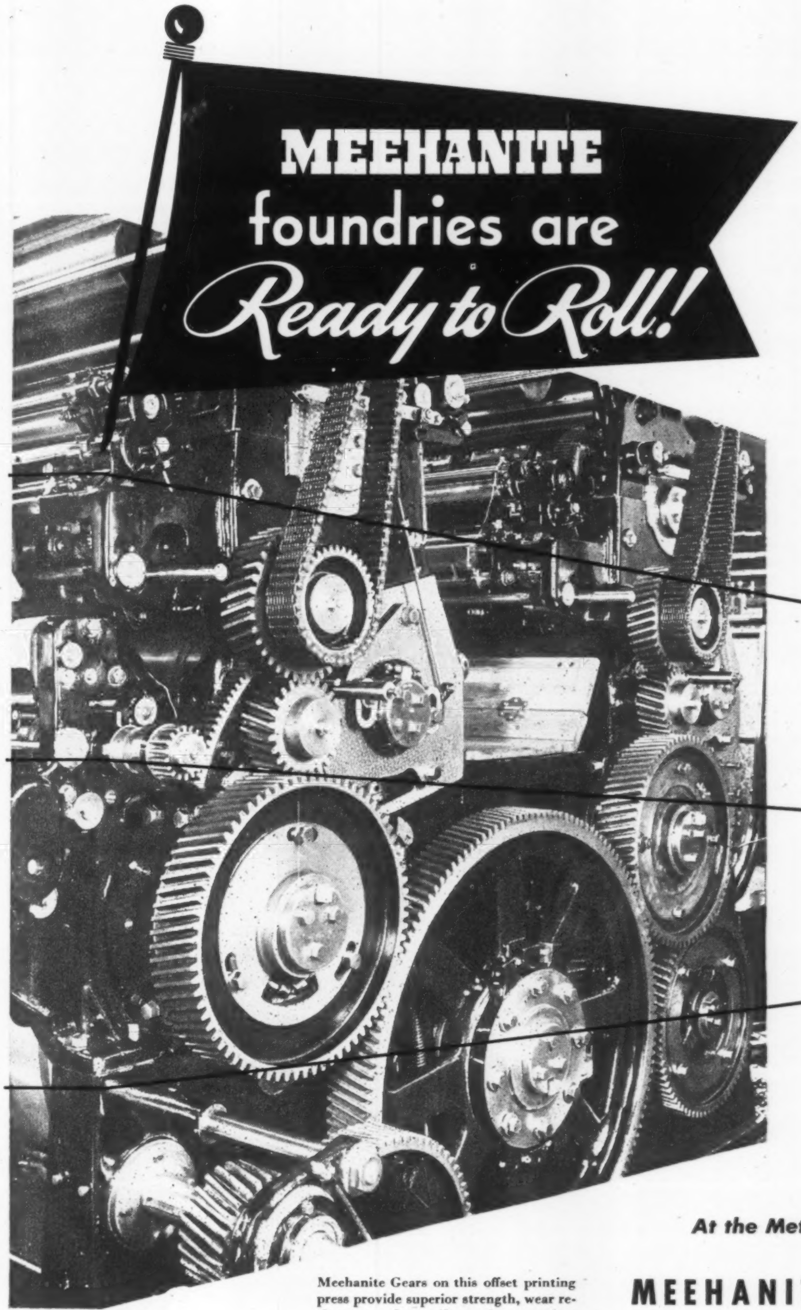
Z

Zapon-Brevolite Div., Atlas Powder Co., North Chicago.

(a) 3-5767 DURANITE synthetic finish in all colors, including opalescent; QE-375 ZAPON machine lacquer in all colors.

(b) Duranite, spray, brush; baked. Zapon, spray, dip or brush; air dry.

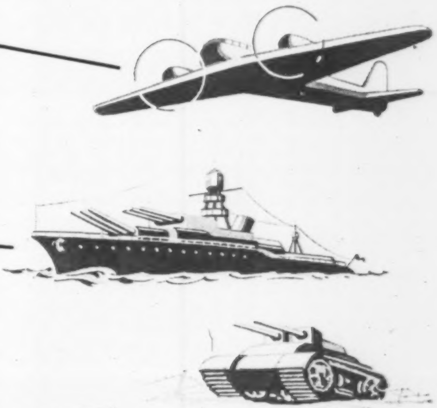
(c) Duranite, decorative, resistance to dairy products and rustproofing, for use in dairy machinery. Zapon is decorative, for general line of machinery.



Meehanite Gears on this offset printing press provide superior strength, wear resistance, and smooth, precise operation.

Like the printing press shown in the picture every Meehanite foundry in the United States is "Ready to Roll"—ready to provide you quickly with *better* castings for your regular or new jobs.

If you are faced with new tasks involving armament or other products needed in the national defense program Meehanite can prove especially helpful to you. Meehanite is an *International* product with foundries all over the world. There are seventeen in Great Britain, for instance, all of which already have had *several years experience* in armament and defense work. *All* the experience, data, service and test records accumulated *there* have been made available and placed in the hands of Meehanite foundries *here*. *You* can profit from it. Take your casting problems to a Meehanite foundry.



At the Metal Show in Cleveland Visit Booth G-5

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311 ROSS STREET PITTSBURGH, PA.

MEEHANITE METAL CORPORATION

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South African Meehanite Metal Co. (Pty.) Ltd.
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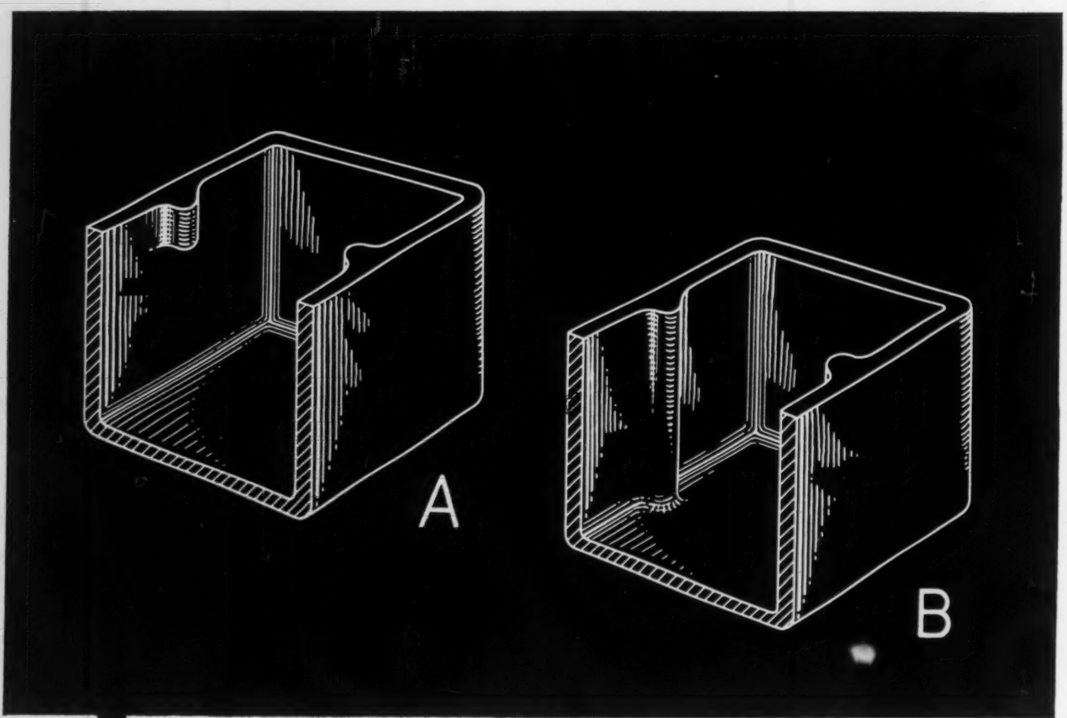
See listing of licensed manufacturers on page 34-D



NUMBER
7 OF
A SERIES

designing FOR DIE CASTING

—*High Production Rates Can Be Assured*

- Since high production rates are a major advantage of the die casting process, any design feature which adversely affects these rates should be avoided if possible.

Undercuts, for example, decrease casting rates, complicate die construction and, consequently, increase the cost of castings. Die casting engineers can frequently be of service in suggesting expedients to avoid undercuts, with cost savings sometimes as high as half of the piece price.

Fig. A shows a typical undercut (see arrow) which can be eliminated by simply extending the boss to the bottom of the casting, as illustrated in Fig. B. This change has not affected the utility of this part, and it greatly reduces the cost of production.

This is the seventh advertisement in a series appearing currently in these pages covering the major factors involved in "Designing for Die Casting". A new book bearing this title may be obtained from any commercial die caster—or by writing to The New Jersey Zinc Company, 160 Front Street, New York City.

ZINC
ALLOY DIE CASTINGS

VISIT
BOOTH D-8
NATIONAL METAL
EXPOSITION
Cleveland Public Auditorium
OCT. 21-25

The Research was done, the Alloys were developed, and most Die Castings are made with

HORSE HEAD SPECIAL (99.99+% Uniform Quality) ZINC

Topics

A PRAISEWORTHY repudiation of accusations that American manufacturers are excessively interested in war orders was furnished recently by Madison-Kipp Corp., Madison, Wis., maker of die castings and die casting machinery. Following the attack by Russia on Finland, the company refused to fill an order placed earlier by a Soviet purchasing agency, although payment for one-third of the amount had been received. The order had not been formally accepted, however.

◆

IT'S no news that many of our most useful machines and methods were discovered accidentally. R. J. Scott offers two more such stories. Workmen at a Vienna exhibition in 1873 in error hooked up a dynamo backwards. You guessed the result: Invention of the electric motor. Benefits of cold rolling steel are said to have been disclosed when a careless worker let a pair of tongs go through rolls. The tongs came out looking like a four-pronged spatula, it is true, but they were shiny and smooth and an idea was born.

◆

AS THE pamphlet, *The Nickel Industry in* 1939, points out, research and development have brought new applications of nickel during recent years which have accelerated the consumption of nickel steels and alloys in a great diversity of forms and compositions. World consumption of nickel in all forms during the first ten months of 1939 totaled 206,000,000 pounds.

◆

SLIGHTLY over a year ago, the Owens-Corning Fiberglas Corp. was organized. Progress in the meantime has overwhelmingly justified the firm's faith in the market for Fiberglas. Although only about 15 uses for the material are visible to the layman, 565 groups of products are now said to be applying it. Personnel of the plant and laboratory has increased 81 per cent since November 1, 1938, and plant facilities have been proportionately enlarged.

◆

CHIEF engineers desirous of increasing efficiency of their subordinates—and who isn't?—will be interested in results of a survey recently concluded by Detroit Edison. Output of the company's draftsmen was investigated last summer and found to be 8,988 "work units" in 5,008 man-hours. After the draftsmen were moved to a new windowless building, completely air-conditioned and lighted with 50 foot-candles at the drafting table tops, production was checked again. A 51.4 per cent increase in efficiency was found—10,474 work units in 3,872 man-hours.

◆

CHALK up another score for American *ersatz.* Mica, directly useful to designers as an insulator, is now being made synthetically. Like many synthetics, the new material possesses the essential characteristics of the natural mineral and a few extras of its own. Basically a gel of Bentonite, a plentiful colloidal clay, and water, synthetic mica is called Alsifilm (*al*uminum and *si*licon) and can be made economically in films ranging from .001 to .005-inch thick, in any width and length. It can be laminated with or without addition of synthetic resins and other adhesives.

◆

COLOR experts have been known to throw up their hands in dismay at the continued use of black. (Old-time automobile manufacturers, you remember, used to say, "Give the customers any color they want—as long as it's black!") A new black electroplating process, however, shows there's life in the old color yet. Depositing twenty times more rapidly than nickel at low current densities,

(*Concluded on Page* 84)

Topics

SINTERED alnico, the powder metal alloy of aluminum, nickel, iron and cobalt, made news sometime ago through its ability, without special mounting assembly, to serve as a permanent magnet and lift 500 times its own weight. Last year an assembly was perfected which permitted a piece of the same material to lift metal 1500 times its weight. Now, out of the General Electric laboratory, comes news that a still better mounting has been developed which enabled a tiny piece of alnico to lift and hold 4450 times its weight. The new mounting is brass and iron in which the magnetic flux, in bridging from pole to pole, passes through many air gaps instead of the usual two. Goodwin H. Howe, research engineer in charge of the experiments, was quick to point out, however, that the development is strictly a laboratory one, not intended for general use nor to compete with lifting electro-magnets.

◆

A PUBLICATION, "Mechanical Engineering as a Career," of the Institute for Research, Chicago, is useful for engineers young and old. It is a fluent, exciting explanation for youths of the nature and possibilities of mechanical engineering. A young man uncertain about his life's work will find it tells him virtually all he needs to know about the profession before deciding if he wishes to enter it. Older engineers with years of accomplishment behind them will also derive from reading the book a sense of pride in being a member of the group which has done so much in the world's work.

◆

RUSSIAN Five-Year Plans haven't come up to expectations (because of "wreckers"!) and some weird accounts have emanated from the Soviet in regard to experiences with machinery there, but impressive mechanization is taking place, despite the many undoubted handicaps. A recent example was demonstrated at an agricultural exhibition in Moscow in the shape of a "hotbed combine." This machine, driven by an electric motor, looks like a cross between an armored launch and a limousine and moves down hotbed rows, opening and closing frames and performing 22 operations in all. Claimed by fond Bolsheviki to increase hotbed crops 40 to 80 per cent, it transports soil, spreads it, marks it, plants vegetables, fertilizes, sprays, weeds, and waters.

◆

A NEW plating bath has been developed for nickel electrodeposition, consisting of a nickel chloride-boric acid solution instead of the conventional sulphate electrolyte. A finer grained, smoother deposit of superior physical characteristics is said to result. Moreover, control of the bath is easier and power consumption is considerably lower than in conventional sulphate baths.

◆

TRAPPING and storing energy from the sun and utilizing the power contained in radioactive elements have long been two of scientists' most gleaming dreams of the future. Work with elements such as radium is going on apace, although the point is still distant when force from a gram of the metal will drive a steamship across the ocean. At M.I.T., however, one of the first concrete experiments on harnessing the sun's heat for productive purposes on earth is under way. An experimental house has been built which will collect heat on its roof and store it in the basement for uses such as power generation, winter house heating and summer air conditioning. Heat is collected underneath the roof in a black-painted box under which are metal tubes circulating water. The water passes through carefully insulated pipes to the storage tank in the basement.

◆

TWO recent technical reports to congress by the National Advisory Committee for Aeronautics contain some startling, though scarcely unexpected, predictions as well as sound aeronautical engineering information. Nonstop flights to Europe with full loads—military or commercial—are prophesied within a year or 18 months, based on airplane speeds of 450 to 500 miles per hour, close to the present theoretical limit. The design innovations leading to these breath-taking accomplishments include the publicized new streamlined wing which is expected to cut the air with only a third the pres-

(*Concluded on Page* 86)

Topics

AN AUTOMATIC electrical device which responds to the almost unmeasurable electrical charge in the human body, has been made commercially available by RCA Victor. A capacity-operated relay, the device utilizes no photocell or light beam but is energized when a person approaches. Applications, as might be expected, are almost unlimited, particularly in the field of advertising and sales promotion for displays, etc. The device operates from a 110-volt, alternating current power supply.

◆

RADIO broadcasting of the frequency modulation type apparently is far superior in many ways to the conventional amplitude modulation system now in use. An organization has been formed of representatives from stations with permits to construct and operate frequency modulation broadcasters. Unfortunately, however, the frequency modulation stations occupy the region of the ether next to that used by television broadcasters, and there isn't room for all the applicants who wish to use the new system. Accordingly, FM Broadcasters Inc. appeared before the Federal Communications commission during the week of February 28 and asked that one channel be taken from television and given to its representatives, since 30 new frequency modulation stations could be accommodated in that space.

◆

AS IT must to all things, mechanization has come to the mirror manufacturing industry, and the days of hand-pouring silvering solution from a pitcher on a sheet of glass are numbered. Three manufacturers, licensed and equipped by Peacock Laboratories Inc., Philadelphia, have cut silvering time to less than a minute, against the half hour formerly needed. The new process depends essentially on spraying with a pneumatic gun having two concentric nozzles, one shooting the standard solution of ammonia and silver nitrate, the other a secret reducing agent. Mirrors pass by on conveyorized tables. Viewed in long-range perspective, this process is another phase of the trend toward continuous production of articles formerly made in batches. Rayon making is another pertinent example.

◆

POLITICALLY, the Work Projects Administration has failed to bring forth shouts of acclamation from the public. But figures released recently show the much-maligned WPA has done well by machinery manufacturers. Since its inception in July, 1935, through last September, WPA bought $48,930,000 worth of machinery and equipment. Dramatizing in terms other than money, as WPA quaintly does in this instance, man-hours of labor needed in private industry to manufacture the equipment totaled over 92,000 hours.

◆

AMERICAN rights for production of Buna, the German synthetic rubber, were acquired last month by Standard Oil Development Co., subsidiary of Standard Oil of New Jersey. The point need hardly be emphasized that this country's dependence on imports of natural rubber is lessened by each such move which increases our ability to secure synthetic materials. Standard Oil, fortunately, has plenty of butadiene, the basic raw material for making Buna.

◆

IT'S becoming almost commonplace to hear that a new plastic molding material is being made from some substance which seems far removed from the plastics field. Nevertheless, the fact is news that Dr. Joseph Seiberlich, a German chemist now living in this country, has developed a process for converting Irish potatoes into plastics. To help him along, the state of Maine is building a pilot plant for further investigations. The plastic material, which can be made from culled potatoes, includes a type resembling clear glass.

Topics

FIRST metal stretching press to be built and operated in the United States is now in daily use by the Glenn L. Martin Co. near Baltimore. Used principally for forming large sheets like airplane skins or engine cowlings, the press represents a happy medium between hand operation in a power or drop hammer, and high production automotive methods requiring expensive forming dies and extremely powerful presses. It has two hydraulic cylinders placed beneath a platen between two rows of independent clamp jaws, the cylinders being attached to the platen so that they raise or lower the platen vertically. In operation, a form is placed on the platen and a sheet of metal is placed over the form, clamped tightly in both rows of jaws. Pressure applied on the hydraulic cylinders causes the platen to raise, stretching the sheet tightly over the form. Thickness of the metal is reduced only 5 to 7 per cent, while the operation takes only a few minutes.

◆

LIMITED commercial operation of some television stations beginning next Sept. 1 will be permitted by a recent ruling of the Federal Communications commission. Advertisers will not pay for "time," but only for the actual cost of programs. Radio Corp., leader in the television field, will soon begin erection of relay stations for an eastern network. To help things along, RCA has announced a 30 per cent price reduction on home receivers. At the present time, by special dispensation, Sun Oil Co. and Standard Oil of New Jersey are sponsoring 15-minute news telecasts.

◆

BARBERING of pigs may seem a waste of time at first thought, but rubber makes it possible in the packing industry. Specially made rubber hog scraper belts fitted with sharp steel claws scrape off bristles as the porker's carcass revolves. In addition, the belts must be flexible enough to follow the pig's contour without tearing the skin, yet tough enough to withstand destructive action of heat, steam and grease.

◆

PLASTICS haven't yet supplanted lead-tin-antimony as material for printing type, but they are being used for master copy type for three-dimensional pantographic engraving and die-cutting machines. This type is intended for producing steel letter stamps, type and various classes of dies, and comes in three heights and eight widths. Characters are so shaped to permit cutting of sharp inside corners in minimum time.

◆

TWO methods for making glass "invisible" by reducing the losses caused by reflection when light passes through glass were announced last year and discussed briefly in Topics, February, 1939, page 26. Word comes now of the first commercial use of the method in a Bausch & Lomb movie projection lens, which gives marked improvement in image contrast and sharpness of focus. Unreflecting glasses boost screen illumination from 15 to 40 per cent. In fact, when you saw *Gone With the Wind,* the blushes of Miss O'Hara-Leigh were freshened by the new lenses.

◆

HAVE you a hunch the wire in your machines may be under undue strain? If so, the tension meter developed by Hazard Wire Rope division will let you know exactly what stress is being borne by that wire. The tension meter is a metal sounding box with a wire string and tuning key. A user clamps the meter to his rope, plucks both the sounding string (which has been tuned from a pitch pipe) and the wire rope and makes the sounds they give identical by moving a fret on the sounding board. A table then gives the stress in the cable.

Topics

IN ABOUT a year it is possible that you'll be hearing a good deal about "liquid coal" as a fuel for machines. Recently, scientists of Armour Institute of Technology directed by Dr. Francis W. Godwin drove a stock automobile with liquid coal. The only alteration to the engine was removal of one fine-screen filter. When commercial use becomes possible the first applications of the fuel probably will be to machines like domestic oil burners, on which it has been tried during development. Known also as colloidal fuel, three types of liquid coal have been produced, although specially prepared coal ground to 300 mesh is used in each. The coal may be suspended in a mixture of gasoline, fuel oil and lubricating oil; in diesel oil; or in a very light oil, chemical stabilization being necessary in each case. Heat value per cubic foot is said to be greater than that of either coal or oil.

◆

DESIGNERS in close contact with production operations have undoubtedly experienced trouble at one time or another with melting zinc, particularly that used for die-making. Because heat concentrates at certain points of the melting pot, zinc will alloy with the pot metal (steel) at those points and impurities will be present in the final product. The old double boiler principle has been utilized by one company to solve this problem. A large pot with a combustion chamber beneath is covered with a refractory and then used to melt lead. Into the hot lead is dipped another smaller pot containing the zinc. Because heat is thus evenly distributed, the zinc does not tend to alloy with the pot. Another profitable result: Pots last longer, even though now made of cheaper steel.

◆

EVERY year many new parts are brought out by General Electric, but the company recently felt one particular motor deserved extra attention. The unit in question is the largest 60-cycle BTA motor ever built, is rated 400-horsepower, and will develop constant torque over a 2 to 1 speed range of 410 to 205 revolutions per minute. Of open construction, it has speed-changing brushes shifted by a pilot-motor-operated mechanism on the top of the BTA frame. Development of this type of motor was started as far back as 1913 by GE. Advantageous operating characteristics include smooth speed changes, good speed regulation from no load to full load, high efficiency at reduced speed points, simple control and an adjustable alternating current drive in a single unit.

◆

HEAT energy instead of mechanical for pumping? That's the basis for a new "pump" invented by Dr. Vannevar Bush, new president of the Carnegie Institution of Washington. It compresses gases, creates vacuums, or transfers heat against its normal direction of flow. During this work a substantially constant volume of gas is alternately heated and cooled, naturally raising and lowering its pressure. A small burner heats the working substance, and although a blower causes the substance to flow in the proper directions at the proper time, the patent papers emphasize that this blower does not do mechanical work in compression. Experimental work was done at MIT in collaboration with Edwin L. Rose, chief engineer, Waterbury Tool Co.

◆

AN EXPERIMENTAL, ultramodern automobile recently completed by Harley J. Earl, chief of the styling section of General Motors, probably illustrates to a great extent how the cars of the immediate future will look and be designed. The low, streamlined body is mounted on a special Buick chassis, with a 123-inch wheelbase and an experimental valve-in-head straight eight engine. Wheels are small with 13-inch tires, and have aircooled type airplane brakes. The center of gravity is so low that it is said to be almost impossible to turn the car over. Alligator type hood is one piece from die-cast grille to the cowl. Front fenders house retractable headlamps concealed behind fender "doors." Small electric motors controlled by a switch on the instrument panel cause the doors to open and close and manipulate the handlamps into beam position. Doors of course have handles which are flush with the car's side and are operated at slight pressure. All locks are remote controlled from the driver's seat. Not too radical, these changes, but they indicate the trend.

Topics

EXPANSION of welding processes, particularly in the manufacture of products using steel, is evident in the record-breaking total of 183,436,000 pounds of steel welding wire produced in 1939. This output was an increase of 56 per cent over the 1938 figure of 117,395,000 pounds and 18 per cent greater than 1937's total. Even more significant is the fact more than five pounds of welding wire were produced per ton of finished steel last year, compared with 2.6 tons in 1932, during which time production of welding wire rose 760 per cent.

◆

PURCHASE of American rights to the manufacture of buna synthetic rubbers by Standard Oil of New Jersey from Germany was noted in *Topics*, Page 28, March, 1940. Perhaps it is not generally recognized that this sale was merely one aspect of a much larger trend, namely, the effort by Germany to sell patent rights abroad, particularly in neutral countries. Special processes, formulas and techniques already developed in Germany are also being put on the block, notes Arthur D. Little Inc. Two notable objectives: Foreign exchange, and a hedge against later confiscation of patents by countries which might become hostile.

◆

RADIO control for unlocking and opening garage doors and turning on lights inside was put on the market by Barber-Colman sometime ago. A driver had only to press a button on the dashboard without stopping the car, and the auto unit controlled only the garage to which it was tuned. Now B-C has added a new feature—a time delay button that automatically maintains the circuit to the transmitter for ten seconds. When the driver's hands must be free for negotiating a twisting driveway, this is a distinct improvement.

◆

INDUSTRY is frequently accused of withholding patents which if utilized would redound to the public benefit. Establishment of the pioneer products section of General Electric at Bridgeport, Conn., should help to dispel this impression. Inventors both in and out of GE laboratories will be encouraged and devices which are proved to have sales potentialities will be promptly exploited. Back of the whole move is the desire to expand development of new electrical household appliances which will produce sizable sales. Most such appliances were introduced 20 years ago, and the intervening time has seen only improvements and refinements—not new products.

◆

SO-CALLED bullet-proof gasoline tanks used by the German air force have received plenty of publicity lately, although the principles behind them are well-known to American military men. An application closer to home is a new tire tube put out by U. S. Rubber, also said to be bullet-proof and self-healing. To test it, five rifle bullets were fired into an area of the tire one inch square. Little air was lost.

◆

STILL another German development: An automotive brake lining using aluminum or steel wool as a substitute for asbestos, with synthetic rubber as a binder. In manufacture, fine metal fibers about .3-millimeter in diameter are embedded in resin or buna. The fiber lining does not injure by an abrasive effect the metal surface to which it is applied. But since Germany has plenty of aluminum, is the development an *improvement,* or merely an inevitable substitute?

◆

HOW shall sound be controlled most effectively in air conditioned space? To find out, the American Society of Heating and Ventilating Engineers will sponsor a co-operative research project at Rensselaer Polytechnic institute. Three factors must be known to predict noise levels: Probable background noise levels; amount of noise generated by equipment and air in duct system; means of predicting sound attenuation through duct system with and without use of special sound absorbent materials.

◆

DRAVO CORP., Neville Island, Pa., is the type of firm which causes officials of the James F. Lincoln Arc Welding Foundation figuratively to clap their hands. To encourage its employes to participate in the latest Lincoln $200,000 award program, Dravo is offering three cash awards for the best papers written by employes and published concerning progressive development in the plant. After the last competition, four Dravo employes receiving Lincoln Foundation awards were given duplicate checks by the company.

Topics

IMPORTANCE cannot be overestimated of the announcement last month by Goodrich that it has developed a synthetic rubber which actually can replace natural rubber for all applications—including tires. The first manufacturing plant for producing this material—Ameripol—will open in the fall with a daily capacity of several tons. Inasmuch as the yearly consumption last year of synthetic rubber in the United States was about 1700 tons, it is evident that even this initial effort will have significance. A large part of former synthetic rubber uses, it is safe to say, were those in machines. Nevertheless natural rubber used totaled 592,000 tons —a figure indicating our dependence on imported latex. Ameripol comes basically from petroleum and subsequently butadiene, following cracking, separation of a gas and liquefying. After mixing, heating and agitation, an emulsion is derived which is similar to latex, and processing thereafter resembles that employed with the natural product.

◆

FORTY-TWO years ago the first tapered roller bearings were installed in farm wagons and buggies. Since that time applications of these bearings have expanded almost unbelievably. A recent check-up revealed that more than 2500 sizes and kinds are being manufactured today.

◆

LARGE share of the onus for present unemployment is ascribed to the unemployment insurance tax in a report released by the fact-finding committee of the ASTE. Small businesses, or those having less than eight workers, are exempt from the three per cent tax per worker, and hence heads of the concerns frequently stay small deliberately, according to the report. It is pointed out that industrial employment today is identical with 1929 total when unemployment was small, but population growth has outstripped employment increase. At the same time, greater taxation has increased the cost of consumer goods, so that the worker pays more but does not gain increased purchasing power.

◆

WEATHERING resistance of steel increases with increasing nickel content and the addition of optimum amounts of copper, according to a recent paper presented during the annual ASTM meeting. Tests were made over a period of 15 years in all sorts of atmospheres by N. B. Pilling and Dr. W. A. Wesley, of International Nickel's research laboratory. Most startling superiority for nickel-copper steels was shown in marine applications. A moderate amount of phosphorus seemed to be beneficial but other metal additions were unimportant.

◆

PROPERTIES of rubber in compression are discussed thoroughly in an article in this issue of M. D., but a little footnote may be appended here. Rayon cords inserted in rubber have been found to lose liveliness. A new chemical dip has been discovered for the rayon which gives it longer life because of greater resistance to fatigue. Development of electrically conductive rubber by Dunlop should also be mentioned. Chief market now is applications where current leakages must be grounded to prevent danger. Mechanical properties aren't sacrificed, although soft rubber can't be made highly conductive.

◆

FOR prelubricating surfaces not readily capable of lubrication by ordinary means, a liquid coating has been developed which hardens on exposure to light, provides a relatively high resistance to abrasion and has excellent lubrication and corrosion prevention characteristics. Basic element in the coating is colloidal graphite, with small amounts of hardenable organic colloids and a hardening agent, in a water suspension. Elevated temperatures are said to have no effect on the lubricating characteristics of the coating.

◆

USEFUL as a heating and cooling liquid, a new chemical mixture was announced recently by Dr. W. M. Nagle of duPont. A mixture of approximately 40 per cent sodium nitrite, 7 per cent sodium nitrate and 53 per cent potassium nitrate by weight, the liquid will transfer heat of 900 degrees Fahr. and is characterized by thermal stability and a lack of corrosive action on steel at temperatures above those obtainable with hot oil or steam pressure.

◆

GEARS of 30-pitch and finer are usually included in the fine-pitch category, though gear cutters are now being made for turning out 125-pitch gears, with a high accuracy. In a paper presented recently before the annual AGMA meeting it was pointed out that in the near future gear cutters for 200-pitch gears will be made! Gears of this fineness can be produced accurately both as to involute profile and as to tooth spacing.

Topics

REGARDLESS of how many warplanes the Ford Motor Co. could actually build, the fact remains that during the first World War Ford promised to build a submarine chaser a day—and did it. Records of the ASME show that ten days were needed in production to turn out one of the boats—25½ feet wide, 200 feet long and 200 tons in weight. Three assembly lines kept production of 21 ships constantly in motion. Eight thousand men were kept busy. Comments the ASME: "The magnitude of the undertaking, not duplicated since then, staggers the imagination . . . ."

◆

POWDER metallurgy is being put to a new use in connection with a new bearing developed by Buick which will capably withstand a pressure of 2000 pounds per square inch of bearing surface. The bearing comprises a steel backing, a porous matrix of copper and nickel powders, and babbitt bearing material which contains approximately 92 per cent lead.

◆

DEFENSE commissioner Knudsen occasionally takes time out to reassure the country that the publicized machine tool "bottleneck" is being straightened. It has been pointed out also that greatly increased sales of cemented carbides for metal cutting may indicate that individual machines are being required to turn out more work. Production of cemented carbides for steel cutting rose 372 per cent during the second quarter of this year as compared to the comparable period last year. Sales of carbide metals for other purposes jumped 85 per cent. Cost of the material has been reduced in relation to the larger quantities produced.

◆

PERHAPS you've grown tired of reading economists' statements that the last decade wasn't so bad from a business production standpoint, but that output per worker and the number of workers increased too fast. As more concrete evidence that progress certainly wasn't stalled during the period, the *Wall Street Journal* recently listed a few developments that became common in the last ten years. They include synthetic rubber, fluorescent lighting, new plastics and plywoods, polarized and fiber glass, streamlined trains, and television.

◆

INFORMATION from Washington shows that an overflow of letters is being received by various government agencies from manufacturers and trade associations, asking for latest information on industrial mobilization. Most companies are anxious to adapt factory facilities immediately to national defense needs. A memorandum from the department of commerce points out that information of this type can best be secured from field offices of the War and Navy departments. The Navy has 27 major field purchasing offices in 23 cities, the Army 46 offices in 22 cities. These cities are not concentrated but are scattered throughout the country.

◆

UTILIZATION of microfilm as a means of saving filing space was discussed in the June issue of M. D., page 59. At the Martin aircraft plant another new photographic process is effecting great savings of money and energy. A large camera snaps pictures of drawings, negatives are developed and images projected back to large (10 by 5 feet) sheets of aluminum alloy, the surfaces of which have been sensitized with special emulsion. After developing in huge tanks, the sheet shows the drawing precisely—or in fractional or multiple scales if desired. Drawings may be reproduced also on other metals, wood, cloth and paper. Martin prints the master drawings directly on metal of which an airplane is to be made and the parts are cut from the drawings.

◆

HOW safe is your plant? The National Safety council points out that machinery manufacturers have reduced the frequency of injuries to workers by 56 per cent and the severity by 51 per cent during the past 13 years. Reduction in frequency of accidents wasn't quite as good as the average for all industries, but the decrease in severity was larger.

Topics

COMMERCIALLY so new its potentialities are still vague, electrolytic polishing has already proved itself so useful in polishing metal in all shapes that several companies are now employing it. Designers will undoubtedly specify it increasingly. Depending on metal removal, the method is thus the opposite of electroplating, yet a shiny surface results. Parts are placed in an acidic bath and electric current flows toward the anode. The result is a smooth, bright finish difficult to obtain in other ways.

◆

SEVERAL late issues of M. D. have contained articles discussing methods of negotiating with inventors who wish to sell their brain children to companies. For the sake of the inventor it should now be pointed out that a group has been established in Washington which will not be cold toward receipt of outside information about new machines. Rather, the National Inventors Council of the department of commerce is ready, willing and anxious to interview inventors—provided the ideas put forth may be applied to national defense. Chairman of the council is Dr. Charles F. ("Boss Kett") Kettering.

◆

SEVERAL months ago Buick provoked discussion of automobile design trends when it exhibited its conception of cars of about five years hence. Many prevailing manual functions will be operated by remote control in the future, everyone agrees. One such instance is already coming to light. An hydraulic mechanism for operating car windows has been perfected and probably will be applied soon. Each window is operated independently by pushbuttons on the instrument panel.

◆

ONE of the pioneers in hydraulic transmission development has been the Englishman Harold Sinclair. His latest development is a hydraulic coupling for use without a friction clutch on automobiles. Formerly, when a fluid flywheel was used with a transmission in which the different gear ratios were engaged, a friction clutch was needed to make gear changes possible while the car was in motion. The drive now needs to be disconnected only when the car is stationary with the engine running.

◆

MEN have been casting gray iron for a long time, but it's heartening to note the decision of the recently organized Gray Iron Research institute to conduct a program of research at Battelle Memorial institute. Studies will be made at first of the fundamental principles of the cupola melting of gray cast iron and it is expected these investigations will provide groundwork for more accurate control of metal quality and composition. Constant contact will be maintained between the laboratories and member foundries, so that results may be used in practical operations as soon as possible.

◆

IT MAY not mean much as far as American engines or resources go, but recently a Japanese inventor demonstrated a carburetor which, he claims, permits the substitution of soybean oil for gasoline in ordinary gasoline engines. Japan is already using soybean oil as fuel in diesel engines.

◆

IT'S possible the domestic market for powdered iron will soon experience a boom because of the stoppage of Swedish imports. With an eye to capitalizing on this fact, a company in California is beginning construction of a plant for gas reduction of powdered iron, despite previous failures along the same line. Walter G. Clark, president, says he has developed a process in which crushed and screened ore is first maintained at 1550 degrees Fahr. and then fed into tall reduction tubes. At "low" temperatures not exceeding 1900 degrees, reduction is accomplished in hydrogen derived from natural gas.

Topics

DEVELOPMENTS in machine finishes are being announced frequently and the growing importance of the subject is emphasized by the inclusion of finishes for the first time in M. D.'s Directory of Materials. One of the latest and most unusual discoveries is a lacquer enamel which can be washed off quickly with a special solvent, and applied just as rapidly. It is being tested for camouflaging on military aircraft, and might be called a companion material to the "non-visible" paint said to be used on British planes for night raids. Produced in white, black, olive green, neutral gray and other colors, the paint will enable the Army to change colors daily, depending on the terrain to be flown over. Since old camouflage is washed off before new is applied, no weight is added to the plane.

◆

ANOTHER materials note: Indium, the metal considered rare little more than a decade ago, is now being used industrially—as plating for bearings in airplane motors. It has great corrosion resistance, particularly against deteriorating lubricants and acids. Indium is bonded by electroplating to an underlying base containing cadmium, silver and copper, and after heating is diffused into the base. For heavy plates, indium can comprise up to .5 per cent of the total base weight, but in greater amounts it makes the base brittle.

◆

A RECENT tabulation revealed that 53 per cent of all metal working plants in the United States plan to increase productive capacity during the last half of 1940. While around 700,000 production engineers and skilled mechanics will be needed, a great shortage of designers is also apparent. As M. D. has repeatedly pointed out, now is the time to plan for judicious expansion of design departments.

◆

ROTORS and stators in all two-pole turbine generators have an inherent tendency to vibrate but this inclination has been reduced 80 per cent at Westinghouse. Because of deep slots cut on two opposite sides for the field winding, a long, relatively slender two-pole rotor tends to sag twice each revolution, and this double frequency vibration may have an adverse effect on bearings and rings and brushes. By removing metal in the unslotted sectors of the rotor by cutting narrow slots at intervals, rigidity is reduced to compensate for the lengthwise slots, and shaft movements up to eight-thousandths have been reduced to less than one-thousandth inch. In the case of the stator, the tremendous pull of each pole causes the stator to take a slightly elliptical shape, in step with the rotation of the two-pole field, creating a 120-cycle vibration. Two sets of flexible mounting supports reduce vibration transmitted to the frame.

◆

READERS will recall the excellent articles on design features of new automobiles which have been written for M. D. by Austin M. Wolf, automotive consultant. Mr. Wolf recently presented an S. A. E. paper discussing two-engine trucks, vehicles he believes have a definite field. In two-engine designs, the main engine is effective in second, third and high gear only, while a booster engine cuts in and out automatically when additional power is required. The booster is controlled by a vehicle speed governor, a vacuum governor, an accelerator governor and the booster unit's automatic throttle. Since a conventional single large engine must be operated frequently at an unfavorable part-throttle opening, use of the booster engine results in fuel economy.

◆

SIMPLIFICATION and standardization of airplanes has become a popular topic of conversation, following Germany's success along these lines. But at a recent round table discussion of defense at Illinois Institute of Technology, the thought was carried out to its logical conclusion and included all machinery. It was pointed out that at one time automobiles were forbiddingly complex to all except engineers, but that it was possible to centralize the parts actually necessary for operation and so make it possible for anyone to operate them. Role of the engineer is so important in our defense preparations that the speakers agreed "modern war is just another engineering job."

◆

AN UNUSUAL application of hard-facing materials is a process for coating lubricated plug cock valves for service at temperatures as high as 1200 degrees Fahr. and pressures up to 5000 pounds per square inch. For such high temperatures the valves are also subjected to a special lapping operation providing an extremely accurate fit of the plug in the body seat. The hard facing material comes in several grades, depending on whether or not corrosion or erosion resistance is a factor. Use of lubricants particularly adapted to high temperatures is permitted by the hard facing.

Topics

OPENING of the new Durez plant for producing phenol at North Tonawanda, N. Y., is another indication of the growth of plastics as engineering materials. In line with the demand for moldings of constantly larger sizes, the mass production of plastic materials is another step toward utilization of plastics in applications once thought visionary. Technically speaking, the Raschig process by which the phenol is produced—with an absolute minimum of by-products—consists of passing a vapor mixture of benzene hydrochloric acid and air through a catalyst. This produces a mixture of chlorinated benzenes from which mono-chlor-benzene is distilled in the pure state. A vapor mixture of mono-chlor-benzene and steam is then passed through a catalyst which produces phenol and regenerates the hydrochloric acid. These two chemical stages actually form a continuous process.

◆

ELECTRODEPOSITION of brass is almost a century old, but electroplating of other alloys was a laboratory science until the last few years. It has now reached the point, however, where it can replace or supplement coatings of single metals such as chromium, nickel, silver, etc. Uses of these coatings are dictated by the properties of the alloys, but in addition a variety of color tints is available. A familiar application is the electrodeposition of bearing alloys on strong steel backs for the automotive industry.

◆

IN CONNECTION with plating, at the recent Metal Show a new brass plating process was demonstrated which is twice as fast as any previous one. It is carried out by use of high-speed brass salts and anodes in ordinary cyanide equipment and is said to permit smooth bright deposits of controllable thickness.

◆

RECENT figures from the department of commerce show how the war abroad and national defense preparations here have expanded operations of the machine tool industry. Indexes of employment and payrolls were 140 and 160, respectively, in August, 1939. After successive advances they reached 193 and 257 last December, the highest levels since the last war. In July the indexes stood at 235 and 308—and are still rising. Exports were high but have declined since the fall of France.

◆

AMERICAN facilities for fabricating magnesium are being tremendously increased, in line with a prediction made in an article last December in M.D.: "When it is remembered that use of magnesium alloys in the United States did not actually begin until 1915, the amazing development so far is only indicative of what may come." American Magnesium Corp. has announced plant expansions to triple its output. Most of the plants are operating on a 24-hour basis. The increase has been almost directly caused by added needs for aircraft. Foundry facilities in particular will be augmented.

◆

SEVEN months of design work preceded the recent beginning of regular production of the biggest rubber tires in the world, by Firestone. For use on earthmoving machines, the tires weigh 3646 pounds and have a carrying capacity of 55,000 pounds each. They are 9 feet 6 inches in diameter. Six separate castings form the mold—two of steel, two of aluminum for tread rings, and two bead rings. The aluminum tread ring was used because no available engraving machine was large enough to cut the tread design on such a large steel mold.

◆

AN IDEA of the effect of government defense expenditures on machine and parts manufacturers can be gained from figures given out by a typical large company such as General Electric. So far this year orders for the federal government account for more than 25 per cent of the total business obtained. Biggest spurt came during the three months ended Sept. 30, when an increase of 133 per cent in orders was noted. For the first

(*Concluded on Page* 112)

Topics

MECHANIZED warfare is now a household phrase, but the machine has even taken over the first step in the process—the draft. As each serial number was drawn in the recent draft lottery it was photographed by an automatic camera on a continuous strip of miniature film. The exact time it was drawn, the date and the order in which it was drawn were also photographed. Numbers in groups of 250 were then vulcanized to forms from which photoengravings were made. Master lists were printed from these forms, this process eliminating the possibility of error formerly present when master lists were printed from type.

◆

IT WAS probably inevitable, but at last there is a foot-controlled auto radio, made by Zenith. By pressing his left foot down all the way the driver automatically tunes in the next station. A slight pressure causes the radio to soften or go silent, without actually shutting off. Listening can be resumed later without "warming up" the radio.

◆

A COUPLE of years back, you will recall, Jones & Laughlin refined steelmaking by the bessemer process, through use of an electronic cell which discerns changes in the color of the bessemer flame. Since each heat can be turned off at the same time, the quality of the steel is more uniform, whereas formerly the judgment of human—therefore fallible—beings was relied on. Now Owens-Illinois has come out with Duraglas, production of which is aided by better methods of gaging proper mixes, including use of a radio beam to determine fluidity of the molten glass. Duraglas is said to be stronger, lighter, more durable.

◆

LUBRICATION is an integral phase of present studies of surface finish, such as covered in the article by Mr. Schurig in this issue. Hence a discovery by a quartet of chemists from Shell Development Co. may have far-reaching effects on finishes as they are specified by designers. Although the discovery is still in the laboratory stage, it has been found that addition of certain chemical agents to lubricating oils tends to smooth out rough spots on contacting metal surfaces and greatly improve the lubricating qualities of the oil. Other agents with long threadlike molecules, when added to oil, increase the tightness by which the film of oil is held between moving parts, and also are said to improve oil performance. In theory, it is pointed out that localized high temperatures are developed when high points of metal surfaces come in contact. The agents added to the oil are said to change the metal at the high points to a low melting alloy which actually flows into the former minute valleys between the mounds.

◆

COTTONSEED hull, formerly virtually useless, is the base of a new, very hard plastic. Selling for $4.50 a ton, cottonseed hull is fed to cattle or burned for fuel. The discovery is important not only because it adds the basis for another plastic to the present long list, but because it plugs a leak in the southern "cotton economy."

◆

CAST armor plate was mentioned in "Topics" last month as a remote possibility for Chrysler tanks. The idea wasn't so visionary after all, it now develops. Blaw-Knox has received a "substantial" order for cast armor. Familiar characteristics of castings are valuable in this case, and include ease of streamlining, irregular shapes, rapid production.

◆

NOTES on materials and the war abroad: An extensive program of expansion by Aluminum Company of America in the interests of national defense will provide an output of aluminum in 1942 of 700,000,000 pounds, more than double 1939 production. At the same time the price has been reduced a cent a pound. As far as materials of all kinds needed for electrical equipment are concerned, a recent Westinghouse report indicates that less than two per cent of such materials now need to be imported. Of these, supplies are on hand sufficient to last from 10 to 36 months without addition.

◆

AUTOMOTIVE and electrical industries are likely to remain the largest users of plastics for many years, according to H. M. Richardson of General Electric's Pittsfield plant. He points out that the dielectric characteristics of plastics are their greatest selling point, and automotive and electrical industries benefit most from this feature. Emphasizing the increasing engineering applications, Mr. Richardson says the automotive industry recently replaced the electrical as the largest single user.